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CLIMATE AND SOIL LEACHING VARIATIONS IN QUEBEC[1]

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Russian soil scientists have for many years considered climatic conditions to be the chief factors governing soil differentiation. In other countries during the past decade soils students have been giving increasing attention to the effects of climate.

In drawing conclusions as to the duration of existing climatic conditions it should be borne in mind that in very recent geological times our entire country was covered with ice all year round and it is improbable that life in or on the soils survived during the many thousands of years that this glaciation persisted. There may have been small "islands" of biotic survival, several thousands of feet above mean sea level, here and there within the glaciated country, but these must have been but sparsely populated with such flora and fauna as exist today in normal regions well within the Arctic circle. It is altogether likely that the climate in Eastern North America, during the time that has elapsed since the last glaciation, has been at least as cold and as wet as it is today. The meteorological data presented in this paper may probably safely be regarded as typical of, or less severe than, the conditions that have prevailed since the starting-up of life in and on the soils released from the grip of the Labradorean ice sheet.

An important question, which must be answered in the negative, is—are our soils mature; have they had time, since the last general ice sheet and the water resulting from its melting left them bare, to reach equilibrium with their environment?

A large part of the area of agricultural Quebec may be classed as lowland country. Glaciation has profoundly modified all the soils of the province, but none to a greater extent than those of the lower Ottawa, Richelieu and Middle St. Lawrence river valleys. During glacial times all of this country was covered with a great thickness of ice and during the slow glacial recession the deposition of "Leda" clay and of "Saxicava" sand took place from saline waters. The names "Champlain" or "Leda" are applied to the late glacial and post-glacial marine clays of the Richelieu, St. Lawrence and Ottawa river valleys. These clays vary in their chemical composition and the percentages of silt and sand fractions. "Blue", "Red", "White", "Brown", etc., are used to define locally observed colour in clays due to physical and chemical variations. In very many cases the Saxicava sand overlies the clay in shallow banks. On digging a few feet down, through the sand, clay is encountered.

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To interpret correctly present-day variations in mineral content of these lowland soils it is necessary to consider that they are water-deposited; and furthermore that in large part they have arisen from Palaeozoic rocks pulverized by glacial action. In the lower Ottawa river valley a part of the Champlain sands and clays was derived from the Precambrian rocks of the Canadian "shield" of igneous rock to the north, a small part from Archaean limestone, and a part from the underlying Palaeozoic limestones and shales. Generally the clays contain a considerable amount of ground-up limestone, and are therefore well-supplied with calcium. This is evidenced by their chemical composition, reported elsewhere (*2*). The clays to the south, the Richelieu river valley lands and much of the wide St. Lawrence plain, are probably mainly derived from Palaeozoic rocks. It is probable that the clay and sand deposits are morainic material and "rock flour" or "boulder clay" stripped by glacial action from the rocks and left by the ice. This material has been re-worked and transported by the waters of fresh-water lakes and rivers and by the waves of the salt Champlain sea.

There are, of course, great variations in the depth of the unconsolidated clay material. Where the lowlands slope upward to meet the hills the clay deposits thin out, e.g., in northern Hull and Joliette counties, in southern Montmagny and Shefford counties, and at the base of the Monteregian hills. Usually at the base of the latter elevations beds of sand exist as relics of wave action on the beaches of the Champlain sea.

The length of time that has elapsed since the recession of the last ice-sheet which covered Southern Quebec is a question of great importance in any discussion of soil conditions. The climate of course varied as the ice-sheets advanced. To illustrate the tremendous shift in climatic conditions that occurred on the North American continent, it has been pointed out by Antevs (*1*) that musk-ox remains have been found in the states of Indiana, Illinois, West Virginia, Missouri and Iowa, outside the limits of direct glacial action. The musk-ox today is known to be an inhabitant only of far northern regions. In the same states the shifting of biotic factors in response to climate is illustrated by the distribution of conifer fossils, species which today inhabit regions very much further north.

It is not intended to claim that, during the ice retreat, the climate of the southern part of Quebec was necessarily like the Arctic climate of today. It was probably warmer during the summers because of the angle of the sun's rays.

The best estimate that has been made as to the length of time that has elapsed since the retreat of the glaciers from any given points in North America has been made by Antevs (*1*). Conditions during the glacier's retreat caused ponding of water and from these impounded waters sedimentation took place. Study of the yearly accumulations of these glacial water sedimentary layers, or "varves", enables effective determination of the length of time that elapsed from the beginning until the end of the deposition. The nature of the sedimentation from salt water differs from that occurring from fresh water. There seemed to be no consistent rate of retreat of the ice front. Fluctuations in rate were the rule. The thickness of the varves varies greatly; if very thick they evidence the fact of rapid melting of ice and consequently

water heavily charged with alluvium; if very thin they are evidence of diminished melting.

According to Antevs, in the last glaciation the ice edge, during recession, stood in the vicinity of St. Johnsbury, Vermont, for at least 200 years. No very good evidence exists as to the length of time taken by the ice front in its slow retreat northwards through the Quebec Eastern Townships region. During the retreat of the ice front, while sedimentation from fresh water took place at the beginning of deposition, apparently after about 125 years from the uncovering of the land, through recession of the ice front, sedimentation from brackish water was commencing in the vicinity of Delson, eight miles south of Montreal. At Ottawa fresh water clays occur beneath marine clays south of the river, but not five miles north of it. At Maniwaki, in the Gatineau river valley, the clays are of fresh water origin, indicating that the salt water of the ocean (the Champlain Sea) did not penetrate so far inland. Retreat of the ice front from the latitude of Stoney Lake, Ontario, 88 miles northeast of Toronto, to a latitude a few miles south of Maniwaki may have taken about 10,000 years time, as pointed out by Antevs. He sums up the probable length of time elapsing during the recession of the ice front from the terminal moraines on Long Island, New York, to a point north of Cochrane, Ontario. His estimate is, "Probably 28,000 to 29,000 years." This is the best estimate that has been made of the length of time elapsing during retreat of the great glacier. It was during this time that most of the clay, silt and gravel deposits of the Ottawa, Richelieu and St. Lawrence river plains were laid down.

Antevs remarks, with reference to the geologic history of the North American and European continents, " . . . . the last ice sheets had their greatest extent and began to wane about 40,000 years ago. This figure may be less than 10,000 years too large or too small—a fact of importance because of the interest that has recently sprung up in the absolute Quaternary chronology." If we accept 50,000 years ago as the time of greatest ice extent and 29,000 years as the time of recession to "north of Cochrane" this leaves about 20,000 years as the elapsed time since the ice sheet left all of the agricultural soils of Quebec Province. If we accept the other approximate figure suggested as the time of greatest ice extent, namely, 30,000 years, it would appear that the last of the great ice sheet of the most recent glaciation in North America may have left this continent in historical times.

Many of the characteristics of the soils in the region of Quebec Province under discussion may be attributed to their glacial origin. Our very fertile heavy clays have arisen, not from already leached and long-weathered particles, but from ground-up "rock flour" which was carried relatively short distances before deposition. Another extremely important consideration is that these clays are literally *rock flour* and contained when deposited little, if any, plant organic matter, which plant material, through production of organic acids, might cause harmful chemical changes and, notably, an excessive loss of alkali metals and alkaline earth metals from the soils, under cold, wet climate conditions.

It is probable that, except on high mountains, there is no surface ice left on the North American continent as a record of the last general glaciation, but there is a vast amount of underground ice which does not thaw from year

to year. It is likely that much of this subterranean ice of the tundra has persisted through the centuries since the retreat of the glacier. The permanency of this ice is such that the sleepers of the Hudson Bay Railway in northern Manitoba have been laid on it.

Several attempts have been made to represent the climates of various points in terms of relations between such climatic factors as temperature, humidity and precipitation. Amongst the relations proposed have been: (a) Lang's (*3*) Regenfaktor, viz. the ratio of mean annual rainfall to temperature; (b) Meyer's (*4*) N/S (Niederschlag-Sattigungsdefizit), the ratio of rainfall to the difference between the actual humidity and the saturation humidity; (c) Patton's equation (*5*), used also by Prescott (*6*), $e = 0.8\ d$ in which e is the evaporation in inches of water and d is the deficiency of vapor pressure (from saturation) in millimeters of mercury; (d) Crowther's (*7*) rule that for each degree of rise in Centigrade temperature an increase of 3.3 cm. in rainfall is necessary to maintain constant leaching conditions; (e) an inverse relationship between the mean annual temperature and the soil content of nitrogen and organic matter has been established by Jenny (*8*) in the humid areas of the United States possessing equal vegetative cover.

As Jarvis (*9*) has pointed out, not only must temperature, rainfall and relative humidity be considered, but also such factors as the duration and intensity of sunlight, the height above mean sea level, the length of frost-free growing season and the distribution of temperature, the topography, and the previous geological history of the country. It is the summation effect of all environmental factors, including the meteorological conditions and the soil conditions largely influenced thereby, that determines the efficiency of building of desirable vegetable tissues.

In normal seasons under Quebec conditions temperature is the most important meteorological factor. Moisture in some seasons is deficient, but the temperature is too low for best growth of most crops during the spring months. This reduces the length of the growing season, for within the limits of growth temperature determines the rate of activity of most plant processes, as for example, the germination of seeds, photosynthesis, water absorption, the absorption of gaseous and mineral constituents, maturation and seed formation. It has been shown that the intake of water by growing plants from soil is greatest at that temperature optimum for growth. The evaporation of water from soils that have received a heavy burden of winter snows lowers the temperature of the soils.

In any study of the relation between climatic conditions and soil conditions in Quebec it must not be overlooked that during about five months of each year there is almost complete suspension of biological activities and cessation of leaching. The soil is usually frozen to a depth of several feet.

The area of southern Quebec under consideration in this paper is bounded on the north by the Laurentian mountains, on the south and east by the United States border, (Maine, New Hampshire, Vermont and New York are adjacent states), on the east by the gulf of St. Lawrence and on the west by the province of Ontario. Much of the fertile land of the province is included in this area.

Temperature and rainfall data are available from more than a score of meteorological stations located throughout the area. Sunshine records and

records of length of the growing season, marked by last frost in spring and first frost in the autumn, are available from seven stations, five of which are located on stations of the Federal Experimental Farms system, one at McGill University observatory in Montreal and one at the Dominion of Canada observatory in Quebec city. Meteorological records have been furnished to the author directly by the officer in charge at each of the 7 observation points. This assistance is gratefully acknowledged.

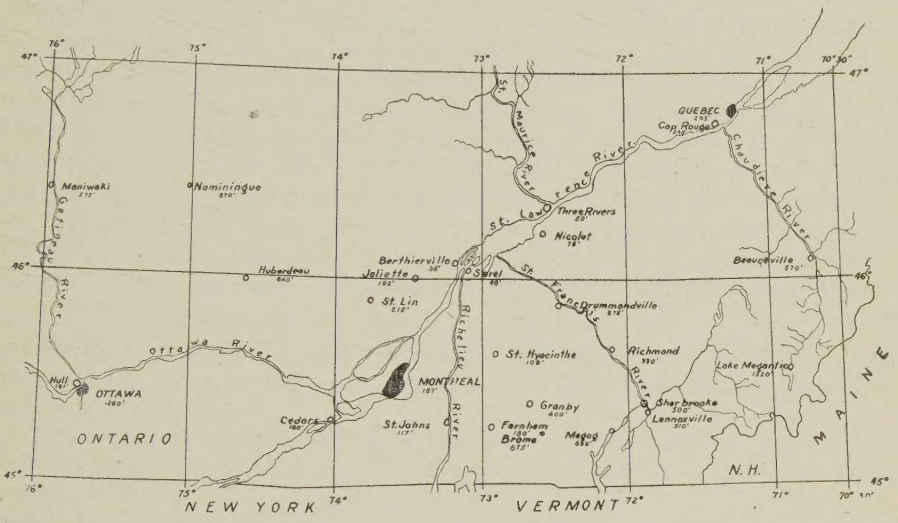

Figure 1. Map of Central St. Lawrence River Region of Quebec.

Meteorological records gathered at stations located in cities are affected by several factors that do not apply at stations located in the open country. Smoke and dust are the chief of these. Not only is the temperature probably affected by reflection of heat rays back to earth from the city's smoke and dust pall, but precipitation is also likely affected, for smoke and dust particles furnish condensation centres for the rain drops that precipitate atmospheric water vapour. The observatories in the cities of Quebec, Montreal and Sherbrooke record higher temperatures than are recorded at other points near them. In the case of the McGill University observatory in Montreal the influence of Mount Royal may affect the amount of precipitation. Similarly, the Quebec observatory records may be affected by the elevation above the St. Lawrence river. Bright sunshine, strangely enough, is the factor that seems to be least disturbed by city conditions.

In Tables 1 to 5 data are shown for the 7 stations, listed from east to west: Ste. Anne de la Pocatiere, Quebec, Cap Rouge, Lennoxville, Farnham, Montreal and Ottawa. The records given include temperature, precipitation, sunshine and length of growing season. In the cases of several long-established stations records are given for the whole period of years for which they are available. For all 7 stations data are given for the same 12 year period, 1919-1930, in order to afford comparison. Tables 1 to 5 show temperature, precipitation and sunshine records as follows:

(1) For each of the 7 months of the season during which significant growth in fields may occur, April to October, inclusive;

(2) A summary for the 3 hot months, June, July and August;

(3) A summary for the 7 months of the growing season;

(4) A summary for the 12 months of the year.

In Tables 6 and 7 data are presented which show mean monthly temperatures in degrees Fahrenheit, and average monthly precipitation in inches, reported from 15 other meteorological stations in the region of Quebec province under study, for each of the 7 months of the season April to October, inclusive. Also summaries are given showing conditions during the 12 months of the year, during the 7 months defined here as "the growing season", and during the 3 hottest months, June, July and August. The data in Tables 6 and 7 have been obtained from the Canada Year Book, 1931, and were furnished thereto by the Canadian Meteorological Service, (A. J. Connor, Climatologist). The data are presented in the Canada Year Book, 1931, as "normal" figures, and represent temperature and precipitation recorded at observation points during different seasons and for varying lengths of time.

The data from 21 observation points (all those mentioned previously in this paper except Ste. Anne de la Pocatiere, which station is probably more representative of conditions in the lower St. Lawrence river) have been used

TABLE 1.—*Monthly average inches precipitation (10 inches of snow = 1 inch of rain).*

	Ottawa		Montreal		Farnham	Lennoxville	Cap Rouge		Quebec		Ste. Anne de la Pocatiere
	12 year period 1919-1930	41 yrs. ending 1930	12 year period 1919-1930	57 yrs. ending 1931	12 year period 1919-1930	12 year period 1919-1930	12 year period 1919-1930	20 yrs. ending 1931	12 year period 1919-1930	55 yrs. ending 1931	12 year period 1919-1930
April	2.70	2.23	3.38	2.53	3.22	2.87	3.22	2.77	3.45	2.41	3.12
May	2.69	2.83	3.22	3.13	2.70	3.90	3.12	3.50	3.49	3.27	3.18
June	3.89	3.54	3.94	3.58	3.16	3.63	3.82	4.23	3.96	3.95	2.60
July	3.60	3.76	3.54	3.71	3.57	3.66	4.35	4.00	4.57	4.18	3.77
August	2.46	3.08	3.42	3.42	3.22	3.82	3.33	3.70	3.70	3.87	3.00
September	2.98	2.86	3.56	3.58	3.35	3.47	3.88	4.22	4.07	4.01	3.06
October	2.99	2.67	3.63	3.34	3.44	3.91	3.85	4.03	3.68	3.48	3.31
Average total during June, July and August	9.95		10.90		9.95	11.11	11.50		12.23		9.37
Average total during the growing season	21.31		24.69		22.66	24.26	25.57		26.92		22.04
Average total annual		34.64		40.94	36.84	38.75 17 yrs.		42.00		42.37	33.42 19 yrs.

TABLE 2.—*Mean monthly temperatures in Fahrenheit degrees.*

	Ottawa		Montreal		Farnham	Lennoxville	Cap Rouge		Quebec		Ste. Anne de la Pocatiere
	12 year period 1919-1930	41 yrs. ending 1930	12 year period 1919-1930	57 yrs. ending 1931	12 year period 1919-1930	12 year period 1919-1930	12 year period 1919-1930	20 yrs. ending 1931	12 year period 1919-1930	55 yrs. ending 1931	12 year period 1919-1930
April	40.3	41.6	40.4	41.1	40.1	39.0	35.0	36.6	36.4	36.0	34.7
May	54.3	54.7	54.6	54.9	52.7	50.2	50.6	50.7	51.3	50.9	48.7
June	64.5	64.6	65.2	64.6	62.9	60.9	59.9	59.4	62.3	61.1	59.4
July	68.0	68.7	69.6	69.5	66.9	65.6	65.2	65.8	66.9	66.9	64.5
August	65.8	66.2	67.2	67.0	65.1	63.7	62.7	62.9	64.1	64.0	61.8
September	58.8	58.6	59.5	58.7	57.7	56.1	55.1	55.0	55.8	55.9	54.5
October	46.0	46.3	47.1	46.7	46.0	45.2	44.9	45.0	44.6	44.0	43.6
Mean temperature, June, July and August	66.1		67.4		65.0	63.4	62.6		64.4		61.9
Mean temperature during growing season	56.8		57.7		55.9	54.4	53.3		54.5		52.4
Mean annual temperature		41.7		42.4	42.0 14 yrs.	40.3 17 yrs.		39.0		39.2	36.5 19 yrs.

TABLE 3.—*Monthly average hours bright sunshine.*
Data for each station are given for the 12 year period, 1919-30 inclusive.

	Ottawa	Montreal	Farnham	Lennoxville	Cap Rouge	Quebec	Ste. Anne de la Pocatiere
April	186.9	165	157.8	158.5	164.4	160.7	152.4
May	232.6	197	205.4	203.3	195.4	193.7	197.4
June	255.0	214	217.9	207.4	189.1	210.1	200.4
July	281.2	234	235.8	240.9	223.7	227.6	246.5
August	250.6	210	221.5	217.4	212.5	207.4	219.6
September	184.0	169	160.5	161.4	148.5	160.0	154.8
October	139.4	128	118.2	128.7	111.8	125.1	108.9
Total during June, July and August	786.8	658	675.2	665.7	625.3	645.1	666.5
Total during the growing season	1529.7	1317	1317.1	1317.6	1245.4	1284.6	1280.0
Total annually	2040.4 (33 yrs.)	—	1739.8 (13 yrs.)	1737.1 (17 yrs.)	1647.7 (20 yrs.)	—	1669.4 (13 yrs.)

TABLE 4.—*Length of growing season, and dates of first and last frosts.*

	Ottawa Exp. Sta. 41 years ending 1930	Farnham Exp. Sta. 14 years ending 1931	Lennoxville Exp. Sta. 17 years ending 1931	Cap Rouge Exp. Sta. 20 years ending 1931	Ste. Anne de la Pocatiere Exp. Sta. 17 years ending 1931	Montreal McGill Observatory 57 years ending 1931	Quebec Dominion Observatory 12 years ending 1931
Average date in Spring of last temperature of 32°F. or less	May 5	May 19	June 1	May 14	May 20	April 25	May 7
Average date in Fall of first temperature of 32°F. or less	Oct. 1	Sept. 24	Sept. 5	Sept. 28	Sept. 28	Oct. 17	Oct. 11
Average length of growing season, last frost to first frost	149 days	128 days	96 days	137 days	131 days	175 days	157 days
Shortest growing season, last frost to first frost	115 days (1930)	76 days (1927)	58 days (1918)	116 days (1928)	57 days (1927)	—	140 days (1925)
Longest growing season, last frost to first frost	174 days (1893 & 1921)	168 days (1921)	125 days (1920)	174 days (1930)	160 days (1920)	— —	182 days (1927)

TABLE 5.—*Variations in climate at seven observation points. Except where noted data for each station are given for the 12 year period, 1919-30 inclusive.*

	Average daily temperature, °F.			Average daily hours bright sunshine			Average daily inches precipitation		
	Throughout the year	During the growing season	During June, July and August	Throughout the year	During the growing season	During June, July and August	Throughout the year	During the growing season	During June, July and August
Ottawa, Ont.	41.7 (41 yrs.)	56.8	66.1	5.59 (33 yrs.)	7.15	8.55	0.095 (41 yrs.)	0.100	0.108
Montreal	42.4 (57 yrs.)	57.5	67.3	—	6.15	7.37	0.112 (57 yrs.)	0.115	0.119
Farnham	42.0 (14 yrs.)	55.9	65.0	4.77 (13 yrs.)	6.15	7.34	0.101 (14 yrs.)	0.106	0.108
Lennoxville	40.3 (17 yrs.)	54.4	64.2	4.76 (17 yrs.)	6.16	7.24	0.106 (17 yrs.)	0.113	0.121
Cap Rouge	39.0 (20 yrs.)	53.3	62.6	4.51 (20 yrs.)	5.82	6.80	0.115 (20 yrs.)	0.119	0.125
Quebec	39.2 (55 yrs.)	54.5	64.4	4.81 (29 yrs.)	6.00	7.01	0.116 (55 yrs.)	0.126	0.133
Ste. Anne de la Pocatiere	36.5 (18 yrs.)	52.4	61.9	4.57 (13 yrs.)	5.98	7.25	0.092 (18 yrs.)	0.103	0.102

in preparing Table 8. In this table the 21 stations are listed in descending order of value of the southern Quebec P/T factor, calculated for the 7 months of the growing season. (P/T here means precipitation in inches divided by temperature in degrees Fahrenheit and the factor is obtained as described in succeeding paragraphs). P/T values for each of the stations are also shown in this table calculated for the entire year and for the 3 hottest months, June, July and August. The altitude in feet above mean sea level, and the degrees west longitude of the location of each station are also given in Table 8.

A temperature-precipitation factor is obtainable using the ratio $\frac{\text{Yearly precipitation}}{\text{Mean annual temperature}}$. Increasing numerical value of this factor shows greater cold and wetness of climate at any observation point. Under our Quebec conditions this factor is not entirely appropriate, for when the soil is once solidly frozen about the middle of November it normally stays hard-frozen until the beginning of April. Use of the precipitation and temperature data for the 7 months, April to October, inclusive, during which months weathering and biological action in soils freely occur, should be more reliable as an index of the leaching suffered and the decomposition processes in the soils than would be the use of these data for the whole 12 months.

Using precipitation and temperature data from meteorological stations in the region of Quebec that we are considering a factor has been developed to show climatic variation. Let P = inches precipitation in excess of a selected "base" value for precipitation in the area; let T = degrees Fahrenheit in excess of a selected "base" value for temperature in the area. Then the value P/T should prove a more effective index of climatic variation, for it will include only the actual degrees temperature range and inches precipitation range at the meteorological observation points.

In the data available from the stations in the area under consideration the lowest average monthly precipitation, in inches, recorded at any of the observation points, was selected, and that whole number the next below this value was chosen as the "base" value. The lowest average monthly precipitation in this region of Quebec is recorded at Maniwaki in the west: 2.24 inches a month for the 7 months April to October, inclusive. Thus, 2.00 is the arbitrary base, Maniwaki itself having the value P = 2.24 — 2.00 = 0.24. To illustrate further, Three Rivers has the value P = 3.48 — 2.00 = 1.48.

Similarly, the lowest mean monthly temperature, in Fahrenheit degrees, recorded at any of the stations in the area, was selected as the "base" for T. Lake Megantic records the lowest average monthly temperature for the months April to October, inclusive, namely, 52.9°F. Using the next lower whole number, 52, as the base, Lake Megantic has the value T = 52.9 — 52.0 = 0.9; Cedars has the value T = 56.6 — 52.0 = 4.6. To illustrate further, Maniwaki has the value P/T = 0.24/3.4 = 0.07, and Lake Megantic the value P/T = 1.45/0.9 = 1.61, for the 7 months which constitute the growing season.

TABLE 6.—*Mean monthly temperatures, Fahrenheit degrees, April to October, inclusive.*
(Data from Canada Year Book, 1931).

	Beauceville	Berthierville	Brome	Cedars	Drummondville	Huberdeau	Joliette	Lake Megantic	Maniwaki	Nicolet	Nomininigue	St. Lin	Sherbrooke	Sorel	Three Rivers
April	37	38	39	41	40	40	39	37	40	40	38	39	39	39	38
May	50	52	52	53	53	52	53	48	54	54	51	52	53	53	52
June	59	62	60	63	62	62	64	59	63	62	60	62	61	63	62
July	66	67	66	68	68	67	69	65	66	68	65	68	68	68	67
August	63	65	62	66	65	63	66	62	63	66	62	66	64	65	64
September	55	56	56	58	57	59	58	55	57	57	54	56	56	57	56
October	45	44	45	47	46	45	44	44	45	46	43	44	46	45	44
Average of June, July and August	62.7	64.7	62.7	65.7	65.0	64.0	66.3	62.0	64.0	65.3	62.3	65.3	64.3	65.3	64.3
Average of the 7 months	53.6	54.9	54.3	56.6	55.9	55.4	56.1	52.9	55.4	56.1	53.3	55.3	55.3	55.7	54.7
Mean annual temperature	38	40	40	41	40	40	40	38	40	40	38	39	41	39	40

TABLE 7.—*Mean monthly precipitation, in inches, April to October, inclusive.*
(Data from Canada Year Book, 1931.)

	Beauceville	Berthierville	Brome	Cedars	Drummondville	Huberdeau	Joliette	Lake Megantic	Maniwaki	Nicolet	Nomininigue	St. Lin	Sherbrooke	Sorel	Three Rivers
April	1.78	2.78	1.77	1.97	3.95	2.60	2.74	2.80	1.66	3.02	2.49	2.58	2.73	3.11	2.82
May	2.49	2.25	3.39	2.07	3.10	1.98	2.31	2.52	1.80	2.42	1.83	2.60	2.79	2.50	3.26
June	3.69	3.09	4.21	2.94	6.22	3.63	3.79	4.74	1.99	4.08	3.02	3.70	3.72	3.45	3.69
July	3.99	3.48	3.80	2.82	5.51	3.20	3.51	4.20	2.25	4.07	3.27	2.71	3.25	3.19	4.04
August	2.49	2.88	3.89	2.21	4.48	3.33	2.74	2.37	2.58	3.05	2.70	2.87	3.30	2.78	3.36
September	2.51	3.33	3.87	2.67	5.15	4.50	3.24	3.56	2.30	3.30	3.48	3.46	3.79	3.23	3.53
October	3.21	3.33	3.49	3.11	5.15	4.50	3.62	3.97	3.08	3.91	3.92	3.95	3.13	3.46	3.65
Average of June, July and August	3.39	3.15	3.97	2.66	5.40	3.39	3.35	3.77	2.27	3.73	3.00	3.09	3.42	3.14	3.69
Average of the 7 months	2.88	3.02	3.49	2.54	4.79	3.39	3.14	3.45	2.24	3.41	2.96	3.12	3.24	3.10	3.48
Mean monthly precipitation in the 12 mos.	2.68	2.82	2.91	2.26	4.12	2.88	2.72	3.21	2.10	3.14	2.68	2.81	3.08	2.71	3.23

TABLE 8.—*Some meteorological stations of Quebec Province arranged in descending order of P/T values for the months, April to October, inclusive.*

Station	Approximate Altitude, feet above mean sea level	Approximate Longitude, West	P to base 2.00	T to base 52	P/T	P to base 2.00	T to base 37	P/T	P to base 2.00	T to base 61	P/T
			Calculated, as described in text, for the growing season, 7 months			Calculated, as described in text, for the 12 months of the year.			Calculated, as described in text, for June, July and August.		
Lake Megantic	1320	70° 54′	1.45	0.9	1.61	1.21	1.0	1.21	1.77	1.0	1.77
Cap Rouge	248	71° 40′	1.65	1.3	1.27	1.50	2.0	0.75	1.87	1.6	1.17
Quebec	295	71° 12′	1.85	2.5	0.74	1.53	2.2	0.70	2.08	3.4	0.61
Nominingue	870	75° 2′	0.96	1.3	0.74	0.68	1.0	0.68	1.73	1.3	1.33
Drummondville	275	72° 30′	2.79	3.9	0.71	2.12	3.0	0.71	3.40	4.0	0.85
Brome	675	72° 35′	1.49	2.3	0.65	0.91	3.0	0.30	1.97	1.7	1.16
Lennoxville	510	71° 50′	1.47	2.4	0.61	1.23	3.3	0.34	1.70	2.4	0.70
Beauceville	570	70° 45′	0.88	1.6	0.55	0.68	1.0	0.68	1.39	1.7	0.81
Three Rivers	50	72° 35′	1.48	2.7	0.55	1.23	3.0	0.41	1.69	3.3	0.51
Huberdeau	640	74° 40′	1.39	3.4	0.49	0.88	3.0	0.29	1.39	3.0	0.46
Sherbrooke	500	71° 55′	1.24	3.3	0.38	1.08	4.0	0.27	1.42	3.3	0.43
Berthierville	35	73° 15′	1.02	2.9	0.35	0.82	3.0	0.27	1.15	3.7	0.31
Nicolet	75	72° 38′	1.41	4.1	0.34	1.14	3.0	0.38	1.73	4.3	0.40
Farnham	180	72° 58′	1.24	3.9	0.32	1.07	5.0	0.21	1.32	4.0	0.33
St. Lin	215	73° 47′	1.12	3.3	0.31	0.81	2.0	0.40	1.09	4.3	0.25
Sorel	48	73° 8′	1.10	3.7	0.30	0.71	2.0	0.35	1.14	4.3	0.26
Joliette	192	73° 25′	1.14	4.1	0.28	0.72	3.0	0.24	1.35	5.3	0.25
Montreal	187	73° 40′	1.53	5.5	0.28	1.41	5.45	0.26	1.63	6.4	0.25
Ottawa, Ont.	260	75° 40′	1.04	4.8	0.22	0.89	4.7	0.19	1.32	5.1	0.26
Cedars	160	74° 8′	0.54	4.6	0.11	0.26	4.0	0.07	0.66	4.7	0.14
Maniwaki	575	75° 59′	0.24	3.4	0.07	0.10	3.0	0.03	0.27	3.0	0.09

Discussion

As evidenced by the data given in the tables the general trends of climate are for temperature to decrease, precipitation to increase, duration of sunshine to decrease and length of the growing season to decrease from west to east in the area under discussion.

This area falls naturally into 3 divisions: (1) the Appalachian uplands; (2) the lowlands of the great Quebec river valleys; (3) the Laurentian uplands. Within each of these divisions of the area the climatic trends mentioned are much more obvious than if the whole area is considered.

Altitude is a factor of great importance in its influence upon temperature. Thus, Nomininge, in the Laurentians, with an altitude of about 870 feet above mean sea level, although nearly as far west as Ottawa, Ontario, has much lower temperature. Nomininge must be assigned a relatively high P/T value although its precipitation is not excessive. Huberdeau, also well to the west in the area, is about 640 feet above sea level. It, too, has a fairly high P/T value due to its rainfall more than to its temperature.

The Drummondville station records much greater precipitation than any other in this area of Quebec and this gives it a relatively high P/T value in spite of its fairly low altitude and relatively moderate temperature. Maniwaki, the farthest west station of the area, has the lowest P/T value of the stations listed because of its low rainfall, and this in spite of its quite great altitude and fairly low temperature. Those familiar with the upper Gatineau country will recall its usually parched condition in late summer.

Coldness and wetness of climate at any observation point is shown by a relatively high P/T value. High values of P/T in this region of Quebec indicate predisposition to excessive leaching and acid organic matter accumulation in the soils at those points. As far as the observations go, and during the last 5 years this region has been fairly well studied in the field, excellent agreement exists between high values of this P/T factor and the occurrence of heavily leached podzol soils at any point.

The soils of the Appalachian uplands differ in nature from the soils of the other natural geological divisions of the region of Quebec considered. Chiefly because of climatic conditions in the region these mineral soils possess a greater accumulation of acid organic matter. The meteorological records of stations in this district indicate that such a condition should be found as there are relatively high values of P/T. At some stations at high altitudes in the Laurentian region relatively high values of P/T are found which are due either to lower rainfall and higher temperature or to both conditions. In these localities unusually heavily leached soils occur.

It is believed that the use of P/T factors calculated to bases for any fairly large geographical area will give reliable information as to the relative soil conditions, and the general agricultural conditions to be encountered at points throughout the area. Reliable meteorological records may be used more effectively in interpretation of agricultural conditions through employment of such a factor. It must be noted, however, that if used for too large areas the P/T factor to any given bases will lose significance, because of the

differences in duration of winter freeze-up, during which period soil conditions are very unlike those of the months of the warmer, unfrozen season.

Summary

The geologically recent climatic history of Quebec is that of an ice age. The last glaciation profoundly affected the soils as they exist today and they have not yet reached equilibrium with their environment. Although the elevation above mean sea level and the slope of the land are important in causing variation in climate in southern Quebec, the degree of west longitude seems most important. In general, precipitation increases while temperature, length of growing season and sunshine incidence decrease from west to east in the area discussed.

A factor has been developed and applied to the data from 21 Quebec meteorological stations by means of which a measure of the leaching suffered by soils is obtainable. This factor may be got by dividing the precipitation in inches above a base value for precipitation in any area by the temperature in degrees Fahrenheit above a base value for temperature in the area. Excellent agreement exists between observed heavy leaching of soils of the same physical type within the area and high values of this P/T factor.

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EXPERIMENTS ON THE CONTROL OF OAT RUSTS BY SULPHUR DUST[1]

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A number of investigators (*1, 2, 3, 6, 8, 9, 10, 11, 12, 13, 14*) have reported experiments on the control of cereal rusts by sulphur dust treatments. The present experiments, carried out in 1929 and 1930 at Winnipeg, Manitoba, were designed to determine (1) the effectiveness and practical value of sulphur dusting for the prevention of stem rust (*Puccinia graminis avenae* Erikss. and Henn.) and crown rust (*Puccinia coronata avenae* Erikss. and Henn.) of oats, and (2) to study the relation between the degree of rust infection and yield.

METHODS AND MATERIALS

The tests were carried out in a small field of heavy clay loam soil which had been under summer-fallow the previous season. In each year of the investigation the experimental field was sown to Victory oats on May 16. An ordinary seed drill with drills six inches apart was used. After the plants had appeared above ground, the field was divided into 1/400th acre plots. The plots were rectangular in shape and particularly adapted for hand-dusting and harvesting operations. Buffer strips of grain were left at the ends and sides of adjacent plots to serve as protection against dust drift.

In field plot experiments it is important to reduce the error due to soil heterogeneity and to subject the final yield data to statistical analysis. In the present study, therefore, the experiments were planned with consideration of the relation which must exist between the arrangement of experiments and the statistical reduction of the data. Tests of significance were applied to the experimental results.

In order to make the field trials as accurate as possible the Latin Square plan of randomized experiment was used. In each experiment a 10 $\times$ 10 Latin Square was used in which each treatment occurred once, and once only, in each row and each column. The arrangement of plots was as follows: alley; plot; alley; buffer; alley; plot; alley; buffer; alley; etc., etc. This arrangement extended over ten series, each containing experimental plots, alleys, and buffer strips.

The analysis of variance method was used in analyzing the yield data. A complete discussion of the advantages of arranging plots in a Latin Square and of the analysis of variance method is given by Fisher (*4*). Fisher and Wishart (*5*) give full details as to the arithmetical procedure of Latin Square and Randomized Block experiments. For further details in practical application of modern methods of field experimentation a paper by Goulden (*7*) will be found very valuable.

In 1929, the field tests were made under conditions of a natural infection, and, in 1930, under conditions of an artificially induced epidemic in conjunc-

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tion with a naturally occurring one. The 1930 tests must, therefore, be considered as unusually severe.

Dusting operations were commenced just as soon as rust appeared in the district, but not necessarily in the plots. Thereafter, the plots were treated at regular intervals until the oats were ripening. Kolodust, a colloidal sulphur dust, was used throughout the tests. The fungicide was applied by means of small hand-dusters which were checked at frequent intervals during the dusting season to insure reasonable accuracy and uniformity in the rate of application.

Final crown rust readings, according to the scale of percentages adopted by the Office of Cereal Crops and Diseases, United States Department of Agriculture, were made when the leaves were still green; those for stem rust, just before the plants ripened.

The outside drill rows and six inches from the end of each plot were removed by hand before harvest to minimize errors due to border effect. The yield results were then obtained by harvesting and threshing each plot separately. Weight per measured bushel was ascertained by bulking the threshed grain of each replicated series and weighing according to Canadian Grain Standards. The correct marketable grade for each treatment was determined by officials of the Western Grain Inspection Division, Winnipeg, Manitoba.

Experimental Results

experiments in 1929

In Manitoba, stem rust and crown rust of oats in 1929 were not severe, and oats in the experimental plots at Winnipeg were not appreciably damaged. At harvest time, rust and yield data were secured only from three of the ten series of plots included in the Latin Square experiment. The effect of dusting on the amount of crown rust and stem rust infection, and on the consequent yield and quality of Victory oats in these plots, is shown in Table 1.

The results in Table 1 show that the amount of rust in the experimental plots was markedly reduced by dusting. Four 30-pound weekly applications were as effective as eight 45-pound dustings which were made at 3- to 4-day

Table 1.—*Results of sulphur dusting experiment for the prevention of oat rusts. Effect of rate and frequency of dust application on the amount of rust infection, and on the yield and quality of Victory oats in 1929, at Winnipeg, Man.*

Amount of dust per acre in pounds	Date dusted		Mean results of ten 1/400 acre plots				
	July	August	Per cent crown rust severity	Per cent stem rust severity	Weight per bushel in pounds	Yield per acre in bushels	Increase in yield over check, bushels per acre
30	15, 22, 29	5	tr.	tr- 5	37.5	64.6	5.6
45	15, 19, 22, 26, 29	2, 5, 9	tr.	tr.	37.5	65.1	6.1
Check	No dust	—	5	15	37.0	59.0	—

intervals (bi-weekly), the increase in yield due to dusting being 5.6 and 6.1 bushels per acre, respectively. The investigation was continued in 1930, and field experiments were made on a more adequate scale than in 1929.

EXPERIMENTS IN 1930

Two experiments were made in 1930. One was arranged to determine the value of dusting for the control of stem rust and to study the relation between stem rust infection and the yield of oats. The other was designed to determine if crown rust of oats could be effectively prevented by dusting, and, if so, to study the effect of crown rust on yield.

The same dusting program was followed in each experiment. Dusting was begun on July 16. Thereafter, the plots were treated at regular intervals until August 22, when the oats were ripening. Final rust notes were taken August 24, and the plots were harvested August 31.

The results of the stem rust experiment are given in Tables 2 and 3. In Table 2 the analysis of variance is given for yield of oats from one hundred 1/400th acre plots arranged in a Latin Square.

TABLE 2.—*Analysis of variance of the yield of Victory oats in 1/400th acre plots at Winnipeg, in 1930.*

Source of Variance	Sums of squares	Degrees of freedom	Variance	½ $\log_e$	5 per cent point
Rows	3459.51	9	384.39		
Columns	689.54	9	76.62		
Treatments	4534.72	9	503.86	3.1113	0.3484
Error	6511.78	72	90.44	2.2521	
Total	15195.55	99		$z=0.8592$	

Table 2, in which the estimates of variance for rows, columns, treatments, and error are summarized, may be taken as an example to demonstrate the method of analysis used in these experiments. The most important feature of the analysis in Table 2 is the comparison of the estimate of variance for treatments with that of error. If the former is not significantly greater than the latter, it can be concluded, in general, that no real differences between the treatments exist or that the test has not been sufficiently accurate to bring out these differences. In this table the variance for treatments is significantly greater than that due to error. Hence, it may be assumed that some real differences exist between the various treatments in this experiment.

The actual comparsion of estimates of variance is made by the application of Fisher's z test (*4*). The fifth column in Table 2 gives half the natural logarithms of the variance for treatments and for error, and is obtained by multiplying the common logarithm by 1.15129, which is one-half $\log_e 10$. The difference between these half logarithms gives the statistic known as z. In this experiment $z = 0.8592$. Entering Fisher's tables of z, the value of z at the 5 per cent point (20:1 odds) is 0.3484. It must be considered, then,

that the yield differences of treatments observed in this experiment are highly significant.

From the analysis of variance table (Table 2), the standard error of the experiment was calculated directly. Thus, in this test, the standard error of a single plot is the square root of the error estimate of variance.

Expressed as standard error of means of treatments:

$$\text{Standard error} = \frac{\sqrt{90.44}}{\sqrt{10}} = \frac{9.5099}{3.1622} = 3.01$$

In comparing the yield differences observed between the various treatments, differences of less than three times their standard error were ascribed to chance, and as insignificant; differences as great or greater than these were considered significant, and ascribed to such dusting effects as the experiments were designed to examine.

The dusting schedule followed in the stem rust experiment together with the results showing the effect of sulphur dust on the amount of rust infection, and on the consequent yield and quality of Victory oats, are given in Table 3.

TABLE 3.—*Results of sulphur dusting experiment for the prevention of stem rust of oats. Effect of rate and frequency of application on the amount of rust, and on the consequent yield and quality of Victory oats in 1930, at Winnipeg, Manitoba.*

SUMMARY OF RESULTS

Treatment symbol	Per cent crown rust at harvest	Per cent stem rust at harvest	Yield per acre in bushels	Weight per bushel in pounds	Grade	Increase in yield per acre in bushels
A	trace	52	57.4	32	2 Feed	11.1
B	"	25	62.1	37	1 "	15.8
C	"	15	65.9	35	1 "	19.6
D	"	6	68.6	36	1 "	22.3
E	trace	13	61.6	35	1 Feed	15.3
F	"	5	66.9	36	1 "	20.6
G	"	2	67.5	36	1 "	21.2
H	trace	32	62.7	33	1 Feed	16.4
I	"	9	66.4	35	1 "	20.1
J	tr-8	67	46.3	29	2 Feed	—

Standard error of one treatment = 3.01
Minimum significant increase in yield = 9.0 bushels per acre.

KEY TO TREATMENTS

Amount of sulphur dust per acre per application, in pounds	A	B	C	D	E	F	G	H	I	J
	Interval between dustings in days									
	15	10	5	2	10	5	2	15	10	Ch.
0										X
15	X	X	X	X						
30					X	X	X			
45								X	X	

The results in Table 3 indicate clearly that, even in the presence of an epidemic, relatively small amounts of sulphur dust effectively checked the development of rust. There was a very significant response in yield to all the treatments. In every instance the gain in yield and quality of grain was more than enough to cover the cost of the treatment.

At any given dusting interval, 15-pound applications of sulphur were as effective as 30- and 45-pound applications. The length of time elapsing between dust applications was a much more important factor in the control of rust than was the rate of dust application. In the presence of an epidemic the most effective stem rust control, and consequently the most satisfactory improvement in yield and quality of grain, was obtained by applying 15 pounds of Kolodust per acre at intervals of two days from July 16 to August 22. The average yield of the ten undusted plots was 46.3 bushels per acre of No. 2 Feed Oats, whereas the average yield of the ten plots so dusted was 68.3 bushels of No. 1 Feed Oats, an increase of 22.3 bushels per acre and a decided improvement in grain quality.

The results of the 1930 crown rust experiment are summarized in Tables 4 and 5. In Table 4 is given a complete analysis of the yield data. As shown in Table 4, a z value of 1.7896 was obtained in this experiment. As the value of z at the 5% point (20:1 odds) is 0.3484, it can be concluded that the treatment variance is significantly greater than the error variance. It is possible, therefore, to examine the treatment differences in the light of the standard error.

TABLE 4.—*Analysis of variance of the yield of Victory oats in 1/400th acre plots at Winnipeg, in 1930.*

Source of variance	Sums of squares	Degrees of freedom	Variance	$\frac{1}{2}\log_e$	5 per cent point
Rows	1878.85	9	208.76		
Columns	544.04	9	60.45		
Treatments	18442.38	9	2049.15	3.8132	0.3484
Error	4121.62	72	57.24	2.0236	
Total	24986.89	99		$z=1.7896$	

The fact that in 1930 the oats in these experimental plots were heavily infected with stem rust, as well as with crown rust, complicated the problem of determining the actual effect of crown rust on the yield of oats, but produced excellent conditions for studying the effect of dusting on the control of rust. The results are summarized in Table 5.

In this experiment the best rust control was achieved by 30-pound applications which were made at 2- to 3-day intervals (tri-weekly) from July 16 to August 22. In plots so dusted crown rust and stem rust were prevented to a remarkable degree, and the yield of Victory oats was increased 45 bushels per acre, about 153%. Plots of dusted and undusted Victory oats grown at Winnipeg in 1930, are illustrated in Figure 1.

TABLE 5.—*Results of sulphur dusting experiment for the prevention of crown rust of oats. Effect of rate and frequency of dust application on the amount of rust infection, and on the consequent yield and quality of Victory oats in 1930, at Winnipeg, Manitoba.*

Treatment symbol	Per cent crown rust at harvest	Per cent stem rust at harvest	Yield per acre in bushels	Weight per bushel in pounds	Grade	Increase in yield per acre in bushels
A	52	53	37.9	29	2 Feed	8.4
B	32	26	53.5	32	1 "	24.0
C	20	12	58.1	34	1 "	28.6
D	3	3	71.8	34	1 "	42.3
E	21	10	62.9	34	1 Feed	33.4
F	11	3	64.8	35	1 "	35.3
G	1	tr.	74.8	35	1 "	45.3
H	36	30	54.8	32	1 Feed	25.3
I	26	17	60.9	33	1 "	31.4
J	74	61	29.5	26	2 Feed	—

Standard error of one treatment = 2.39.
Minimum significant increase in yield = 7.2 bushels per acre.
Key to Treatments. Same as in Table 3.

From the 1930 results it would seem that, in a severe rust year, the most suitable rate of dust application would be 30 pounds per acre at each application and the most effective interval between dustings from 2 to 5 days. However, this is not a very practical treatment for rust control. The results obtained in 1929 and 1930 do not permit of a final conclusion regarding the

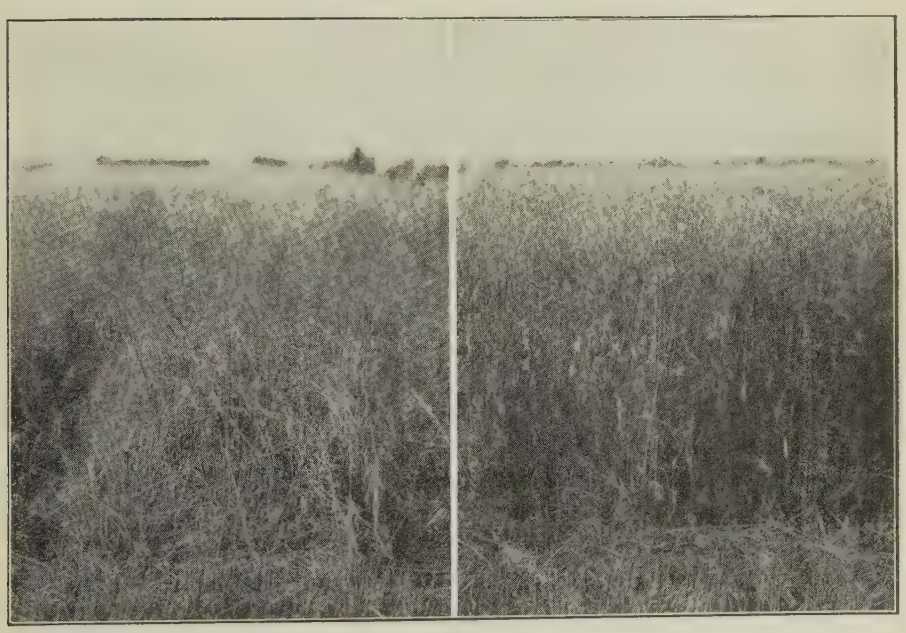

Figure 1. Plots of Victory oats grown at Winnipeg in 1930. Left,—Undusted (check) plot, heavily rusted plants with broken straw and unfilled kernels. Right—Dusted plot, erect clean plants with well-filled kernels.

rate and frequency of sulphur dust application that will give the most effective and practical rust control. It would seem that the most satisfactory dusting schedules will have to be decided each year according to the weather conditions, the progress of the rust, and the stage of plant development, as well as by the control already achieved by previous dust applications.

The data obtained from the 1930 dusting tests were used to study the relation between the degree of rust infection and yield of oats. In the final analysis of the results of each experiment, rust percentages and the yields of individual plots were correlated. The results of the stem rust experiment are given in the form of a regression graph in Figure 2. In the absence of significant amounts of crown rust, the correlation coefficient for this group was -0.65. Its significance was tested by the method given by Fisher (*4*). This involves calculating—

$$t = \frac{r}{\sqrt{1-r^2}} \sqrt{n^1-2}$$

where n^1 is the number of pairs entering into the correlation. For the coefficient -0.65, the value of t was 7.9; while the value of t at the 1% point (100:1 odds) for this coefficient is only 2.8.

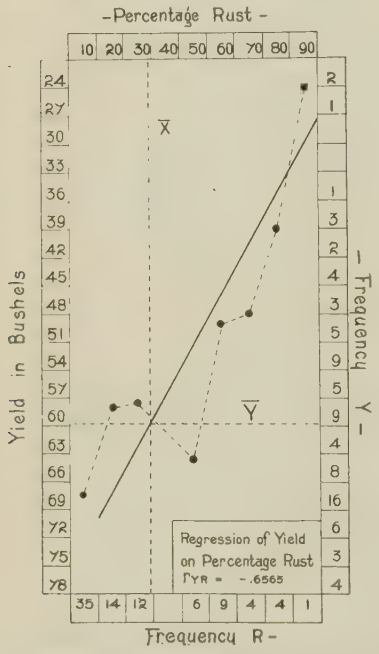

Figure 2. Regression of yield on percentage stem rust in plots of Victory oats from a 10 x 10 Latin Square in 1930.

The determination of the regression of yield on percentage rust, while not entirely satisfactory on account of the low frequency of high rust percentages, gives, however, an approximate value for the reduction in yield corresponding to a given increase in the percentage of stem rust. In this experiment the reduction in yield for each 10% of rust was 4.7 bushels. It seems most logical to express this value in per cent of the average yield of the series of plots in which rust was almost completely controlled by dusting. Thus, the plots given the most effective treatment yielded 68.8 bushels per acre, and represents the average yield of what the entire block of plots would have been if rust had not been present. The reduction of 4.7 bushels for each 10% of stem rust represents 7% of 68.8 bushels.

An important point is the uniform reduction in yield as rust varies from low to high percentages. The straight line regression (Figure 2) indicates that the relation between amounts of stem rust and reductions in yield is linear. To test the linearity of regression, the analysis of variance method as developed by Fisher (*4*) was used. In the stem rust experiment the deviations from the regression straight line were not significant. This indicated that an increase in stem rust from 10 to 20% reduced the yield to the same degree as an increase in rust from 70 to 80%.

Owing to the occurrence of a severe stem rust epidemic in the experimental plots, the data of the second experiment do not permit of a definite estimation of the injury due to crown rust. The yield results in Tables 3 and 5 show, however, that greater losses in yield and grain quality were suffered when both stem rust and crown rust were present, than when stem rust alone attacked the plants. These results emphasize the economic importance of crown rust in oat production.

Crown rust percentages and yields of individual plots in this experiment were correlated. For this group a very highly significant negative correlation of -0.89 was obtained. When stem rust percentages and yields in this crown rust experiment were correlated, the correlation coefficient was -0.88, for which the value of t was 18.6. Again, the odds of significance are much greater than 100:1, as for these odds a t value of only 2.8 is required. Stem rust and crown rust were significantly associated with the yield of oats.

Summary

1. In 1929 and 1930 field experiments were made at Winnipeg, Manitoba, to determine the effectiveness and practicability of controlling stem rust and crown rust of oats with sulphur dust. The Latin Square type of randomized experiment was employed, and the "analysis of variance" method was used in analyzing the yield data. In 1930 a study was made of the effect of these rusts on the yield of oats.

2. Stem rust and crown rust were effectively prevented by dusting even in the presence of severe infestations.

3. In 1929, a mild rust year, 30-pound applications of sulphur made at 7-day intervals (4 dustings) completely controlled rust. Severe epidemics of both oat rusts occurred at Winnipeg in 1930. In that year the best control of rust was achieved by 30-pound applications made at intervals of two days from July 16 to August 22. By such treatments the yield of Victory oats was increased 45 bushels per acre, or about 153%.

4. The results of studies to determine the effect of rust on the yield of oats are given in the form of correlation coefficients and regression equations. The regression of yield on percentage rust was linear, indicating that uniform increases in rust infection result in uniform reductions in yield. Under field conditions in 1930, each 10% of stem rust reduced the yield of oats approximately 7%. Crown rust was found also to be significantly associated with yield.

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CURRENT PUBLICATIONS

DAIRY BARN VENTILATION. Macdonald College Farmers' Bulletin No. 5. L. G. Heimpel, Head of the Department of Agr. Engineering, Macdonald College, Que.

Prof. Heimpel recommends the use of a new type of ventilation system which is given the name of the "Single Out-Take King System", because only a single out-take flue is needed, even in very large stables. Much more effective and reliable ventilation is assured with this system at less than half the cost of the old multi-out-take King and Rutherford systems. The bulletin is based on the findings of a large number of tests of the performance of Rutherford type and single out-take King type systems in fifteen dairy barns in the district supplying milk to the city of Montreal. These tests provide data on the following:—

(a) Rate of air change through the stable.
(b) Temperatures at floor, midheight and ceiling levels.
(c) Air movement or convection of the air in the stables.
(d) Relative humidity of the air, which is an important indication of the efficiency of the ventilation system.
(e) Cubic content available per cow or per animal unit.
(f) Structural details having a bearing on the heat loss from the building and on the maintaining of dry stable walls.

These data showed that, while ventilation is essential to provide healthy stable air, it should not be expected to be a cure for all the wet walls and ceilings found in farm stables. In many cases insulation must be added as well as ventilation. Details for planning, building and operating the system are given.

FISH MEAL SUPPLEMENTS FOR CHICKS

II. COMPARATIVE RATE OF GROWTH-TO-EIGHT-WEEKS ON RATIONS SUPPLEMENTED WITH VARIOUS PROPORTIONS OF FISH MEAL AND DRIED SKIM MILK

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In the first paper of this series (*1*) it was reported that chicks which were fed rations supplemented with salmon or pilchard meal grew just as rapidly to eight weeks of age as chicks fed rations supplemented with dry skim milk. Chicks which were fed rations supplemented with both salmon and milk weighed more at eight weeks than chicks fed rations supplemented with salmon only. The salmon and milk each supplied an equal amount (percentage) of protein, i.e. 3.75 or 5 pounds (a total of 7.5 or 10 pounds) of protein in 100 pounds of the ration. The percentage of protein in dried skim milk is less than in salmon or other fish meals, hence more milk than salmon was fed. Since no information was available as to what results different proportions of dried skim milk and fish meal would give, the present series was planned to test the effects of various proportions of these supplements on the rate of growth of chicks to eight weeks.

EXPERIMENTAL

The chicks used comprised mostly crossbreds (R. I. Red males mated to B. P. Rock and Light Sussex females), with a few of miscellaneous ancestry. All were pedigree hatched and were divided into six lots on the basis of ancestry and sex. The chicks were reared as described in the previous paper.

The basal mixture fed consisted of 50 lbs. ground yellow corn, 10 lbs. wheat bran, 10 lbs. flour wheat middlings, 10 lbs. ground oat groats, 3 lbs. pulverized oyster shell and 1 lb. of salt; 1% of cod liver oil was mixed with the ration every two weeks.

The basal mixture was mixed with the supplements in the proportions shown in Table 1. In Experiment I enough of the supplement was added in each case to provide 7.5% of protein while in Experiment II the amount of protein supplied by the supplements was slightly higher or varied from 8.15% in lot 1 to 9.30% in lot 6.

In Experiment I the ration fed lot 2 corresponded to rations previously fed in that the milk and fish meal each provided an equal amount of protein. It will be seen that lot 1 received a relatively large proportion of milk while lots 2, 3, 4, and 5 received progressively less milk and more fish meal. Lot 6 was at the end of the series and was fed fish meal only.

In Experiment II the rations fed differed slightly from those in Experiment I, in that the milk was reduced (starting with lot 2) by 2.5 lbs. until

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TABLE 1.—*Rations fed.*

Lot No.	Experiment I.			Experiment II		
	Amount of basal lbs.	Amount of halibut lbs.	Amount of dried skim milk lbs.	Amount of basal lbs.	Amount of pilchard lbs.	Amount of dried skim milk lbs.
1	81.9	5.61	12.5	82.0	5.5	12.5
2	82.6	7.01	10.43	83.0	7.0	10.0
3	83.5	9.00	7.5	83.5	9.0	7.5
4	84.3	10.66	5.0	84.0	11.0	5.0
5	85.2	12.34	2.5	85.5	12.0	2.5
6	86.0	14.02		86.0	14.0	

TABLE 2.—*Average weights in grams of chicks in Experiment I based on chicks that lived to the end of the experiment.*

Lot No.	No. of chicks died	No. of chicks alive at end of experiment	Age in Weeks				
			0	2	4	6	8
1		22	34.9	86.5	168.0	304.4	482.4
2		22	33.2	85.4	172.1	318.4	498.7
3	3	20	34.4	82.6	171.3	304.0	486.9
4	4	17	34.8	70.1	144.9	284.9	478.6
5	7	14	34.2	68.6	141.6	260.4	377.7
6	8	11	34.8	61.8	118.1	193.0	349.5

TABLE 3.—*Average weight in grams of chicks in Experiment II. The weights to six weeks are based on chicks alive at that age. The weights at eight weeks are based on the same number of chicks as at six weeks in lots 3, 5 and 6. In lots 1, 2 and 4, due to severe colds, only 4, 4 and 5 chicks respectively survived to eight weeks.*

Lot No.	No. of chicks died	No. of chicks alive at six weeks	Age in Weeks				
			0	2	4	6	8
1	0	14	39.6	72.9	164.8	342.8	497.5
2	3	11	40.0	78.0	194.7	321.4	451.0
3	9	5	39.4	67.6	162.4	335.2	512.4
4	6	7	39.0	68.9	176.6	353.7	535.6
5	3	10	38.8	68.6	167.8	369.6	651.6
6	7	7	39.4	67.9	161.4	276.0	450.6

lot 6 was reached which again did not receive any milk. Halibut and pilchard meal were used in Experiments I and II respectively (Table 1). Since the protein content of the pilchard was 66.41% as compared with 53.46% for the halibut meal, the protein content of the rations fed in Experiment II was slightly higher than that of the rations fed in Experiment I, or about 0.65% (lot 1) to about 1.80% (lot 6). These variations in the protein content of the rations correspond to the variations in the amount of protein supplied by the supplements.

The average weights of the chicks up to eight weeks of age in Experiment I are presented in Table 2. There was apparently no difference in lots 1, 2 and 3 at two, four, six or eight weeks. The chicks in lot 4 grew more slowly than the chicks in the first three lots up to six weeks of age but grew at a more rapid rate from six to eight weeks and, as a result, did not differ significantly from them at the end of the experiments. The average weight at eight weeks in the first four lots varied from 478.6 (lot 4) to 498.7 grams (lot 2). The chicks in lot 5 weighed on the average at eight weeks 377.7 grams. The difference between the weight of these chicks (lot 5) and the weight of the first four lots was over four times its probable error, hence statistically significant. The chicks fed fish meal only (lot 6) grew more slowly than the chicks in the other five lots or weighed only 349.5 grams at eight weeks of age.

The data for the six lots in Experiment II are given in Table 3. Due to severe colds contracted by the chicks in lots 1, 2, 3 and 4 during the last two weeks, the weights of the chicks in these lots at eight weeks are not comparable to those for the chicks in lots 5 and 6. The average weights at six weeks are, however, comparable and may therefore be used instead of the weights at eight weeks. When the average weights at six weeks are compared, it is evident that the differences between lots 1 to 5 are not significant. Lot 6 weighed less at six weeks than the other groups but the difference is not great in some cases. Thus the average weight for lot 2 is 45.4 grams more than the average weight of the chicks in lot 6. Since there were no colds in lots 5 and 6 the average weights at eight weeks for these groups can be compared. The mean average weight at eight weeks of the chicks in lot 6 was 185.71 $\pm$ 23.06 grams less than the corresponding mean weight of the chicks in lot 5. This difference is statistically significant.

The results with respect to mortality are not consistent for the two experiments (see Tables 2 and 3), except that there were no deaths among the chicks which were fed 12.5% of dried skim milk. Since other factors besides the ration fed evidently influenced the mortality, no conclusion is justified with regard to the influence of milk in the ration on mortality.

Discussion

Considering the results of the two experiments together, it is apparent that the chicks fed fish meal only grew more slowly than those fed some dried skim milk in addition to the fish meal. The results for the first five lots of these two experiments differ slightly. In Experiment I the chicks fed 2.5% of dried skim milk did not grow as rapidly as those fed 5% or more whereas in Experiment II the rate of growth for the chicks in lot 5 receiving 2.5% of

milk was equal to that of chicks receiving more milk (a higher percentage of milk). The chicks in the various lots of Experiment II grew more rapidly from four to six (and in most cases to eight) weeks of age than the chicks in corresponding lots of Experiment I. These differences in the results of the two experiments may be due to the use of pilchard fish meal in Experiment II which, as stated above, increased the protein content of the rations used over those which were fed in the first trial.

In neither experiment did there seem to be any definite increase in rate of growth when milk was increased beyond 5% although the chicks receiving 7.5% of dried skim milk in Experiment I apparently grew slightly better to six weeks than those receiving less milk. There is some indication that more milk is required with halibut than with pilchard to produce approximately optimum growth. In earlier experiments it was shown that chicks fed rations supplemented with pilchard fish meal grew better than those fed rations supplemented with halibut. It appears probable, therefore, that the amount of milk that should be fed with fish meal will vary to some extent according to the kind and quality of the fish meal. So far as these experiments went there appeared to be no advantage in feeding more than 5% of dried skim milk with fish meal included in the ration in such amount as to provide a total of 7.5% of protein from both these supplements. This would indicate that the correct proportion is approximately 2 parts by weight of fish meal to 1 part by weight of dried skim milk.

Summary

Two feeding experiments were carried out with chicks to determine the effect of various proportions of fish meal and dried skim milk. The fish meal in the rations ranged from 5.5% for lot 1 to 12.0% for lot 5 and dried skim milk varied from 12.5% for lot 1 to 2.5% for lot 5. Lot 6 received 14.0% of fish meal (halibut in the first and pilchard meal in the second experiment) and no milk. The fish meal and dried skim milk provided approximately the same amount of protein to each of the rations compared.

There was no significant difference in the weight at eight weeks of the chicks in the first four lots in either experiment. In the first experiment, where halibut was fed, the chicks in lot 5 that received only 2.5% of dried skim milk grew more slowly than those receiving more milk while the corresponding group in Experiment II grew just as rapidly as the chicks receiving more milk. In neither experiment was rate of growth increased by feeding more than 5% dried skim milk when fish meal was fed to provide 7.5% or over of protein from these supplements.

The chicks which were fed rations containing fish meal and dried skim milk grew more rapidly than the chicks fed rations containing fish meal. This agrees with the results of previous experiments.

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FURTHER STUDIES ON AMPUTATIONS OF WHEAT ROOTS IN RELATION TO DISEASES OF THE ROOT SYSTEM[1]

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Introduction

The first presentation of the results of these investigations was given at the 1929 meetings of the Canadian Phytopathological Society (*1*). It was stated at that time that a study of artificial injuries of roots, especially in regard to actual loss, might throw some light upon reactions characteristic of root rot diseases. In the above mentioned paper the results of rather extensive greenhouse and field tests were reported.

In the present work we have followed, in general, the same terminology used in the first paper, in which a diagram was given illustrating the parts operated upon. The seminal roots consist of all those originating from the seed (occasionally some rootlets belonging directly to the tiller coming from the axil of the coleoptile may have been included in counting); the crown roots are all of those belonging to the crown nodes (surface roots); and the term subcrown internode is used to designate the internode between these two root systems. When seeds are sown two or three inches deep the parts mentioned above are readily recognized.

The experiments were conducted at the Dominion Experimental Farm, Indian Head, Sask., in 1930. They may be divided into three parts: the first was a study of the influence of injuries received during the seedling stage; the second deals with injuries at later stages of development; and the third was a study of the effects of amputating crown roots at weekly intervals for several weeks. Measurements to determine the development of uninjured plants or checks were made at three-week periods and at other times when the tests demanded supplementary information. These records show the development of the plants throughout the season. Rainfall and soil temperature data were likewise recorded.

General Field Plan and Methods

A total of 65 rod rows, in two ranges was used. Approximately 150 selected, plump kernels of Marquis Ottawa 15 wheat were sown to a row. After emergence the plants were thinned out leaving about the same number of uniform seedlings to each row. The rows were spaced three feet apart in order to give sufficient room for working. The rows selected for the various operations were chosen at suitably distributed points in the two ranges. When the amputations were to be made the top soil was removed from one side of the row, then the remaining soil was removed cautiously until the

[1] Paper read before the Canadian Phytopathological Society, Guelph, Ontario, June 1931. Contribution from the Division of Botany, Experimental Farms Branch, Department of Agriculture, Ottawa.

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desired part was exposed. After the operation the earth was replaced so that at no time were the basal parts unduly exposed. All operations of any particular type were done on the same day.

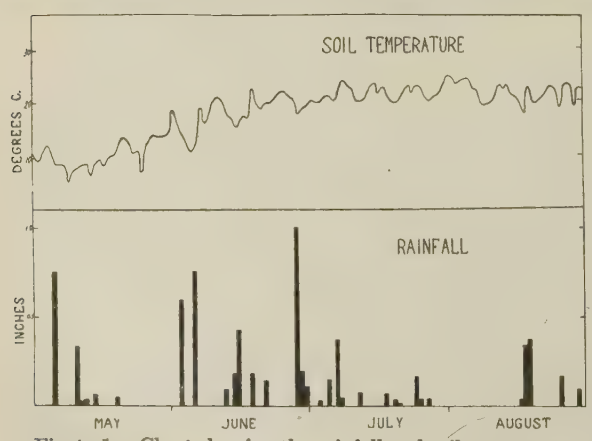
The Development of the Check Plants

Records upon the growth of the plants were kept throughout the season. A definite number of plants, for measuring, was selected from the check rows at three week intervals as well as at times when the operations did not coincide with these intervals. From these notes the stage of development at any time can be readily determined. The growth records are shown in Table 1 and the rainfall and soil temperatures in Figure 1.

Table 1.—*Showing records of growth of the check plants at various periods from seeding to harvest. The seed was sown on April 30 and emergence noted May 16.*

Date	Weeks after seeding	Number of plants measured	Average height in cm.	Average number of			
				Culms	Seminal roots	Crown roots	Heads
May 23	3	25	15.9	1.0	4.6	0	0
June 9		60	20.6	4.1	4.8	3.6	0
" 13	6	100	29.2	5.7	5.1	6.9	0
" 20		100	41.7	6.9	5.2	13.1	0
" 23		25	45.4	7.1		16.2	0
July 4	9	100	74.4	7.8		28.9	0
" 25	12	100	104.9	7.7		50.3	7.6
Aug. 13	15	2352	104.0	9.0	5.2	56.7	9.0

It will be seen that there was a steady and regular development throughout the season. At the end of three weeks the seed had approximately five seminal roots but no crown roots. The next three weeks is marked by active tillering and subsequent crown root increase. After nine weeks the increase in height and number of crown roots are notable changes with a continued increase in tillering. The plants were in the shot-blade stage about this time (just prior to heading). Increase in height and number of crown roots continued for the



Figute 1. Chart showing the rainfall and soil temperatures at Indian Head, Saskatchewan, in 1930, during the period of experimentation.

next three weeks while there was little change in the number of culms and most were headed. The final three weeks reveal no increase in height, only a slight increase in crown roots, but two additional tillers are recorded. Culms were not recorded unless they were headed or were distinctly vigorous; small weak branches were not listed. There were no additions to the seminal system after the first six weeks. The total number of culms includes the tiller which arises from the bud in the axil of the coleoptile as well as subsequent branches from this point. About 80% of the plants produced such tillers. Growth conditions as measured by rainfall and soil temperatures were favourable throughout the season.

The Influence of Amputations during the Seedling Stage

These tests were similar to the field experiments conducted in 1929. The term seedling stage is used in a broad sense to cover the period from germination until crown roots are established. Three types of amputations were studied. Four rod rows were used in each case and the following amputations made: (1) seminal roots on June 9, (2) subcrown internodes on June 13, and (3) crown roots on June 20. The stage of development at the time of the operations can be determined from Table 1.

Shortly after the operations some observations were made. The seminal root amputations caused all the plants to wilt rapidly and many leaves to die back. Frequently the main stem was killed but new tillers came on. In comparison with the checks, these plants had many more small tillers and were noticeably retarded. Approximately 8% of the plants failed to recover. The reaction to subcrown internode cuts was very similar to that caused by the removal of seminal roots. In this case approximately 5% failed to recover from the operation. The crown root amputations did not cause any general symptoms of shock and only slightly over 1% succumbed to the effects of the operation. The plants lost slightly in height and this was never regained.

Table 2.—*Showing the harvest data obtained upon plants receiving either seminal root, crown root or subcrown internode injuries and their checks.**

Checks and amputations	Average number of plants per row	Average height in cm.	Average number of culms per plant	Culms ripe %	Average yield per per plant in grams.	Yields in per cent of checks
Seminal roots	97.5	81.5	5.0	29.5	1.61	36.0
Checks	96.8	103.4	9.3	52.6	4.47	
Subcrown internode	98.5	83.1	4.8	34.4	1.77	38.9
Checks	98.5	103.9	9.3	51.6	4.55	
Crown roots	98.0	94.3	7.6	54.4	3.74	87.1
Checks	99.0	103.7	9.1	50.1	4.29	

* Each type of injury is represented by the average of the plants from four rows. The uninjured rows on either side were used as checks; they total eight in each case, with the exception of crown root checks where the yield was computed on seven rows.

On July 5 most of the culms of the check and crown root amputation plants were in the shot-blade stage. The leading culms in the other cases had a like development. The records obtained at harvest time are shown in Table 2.

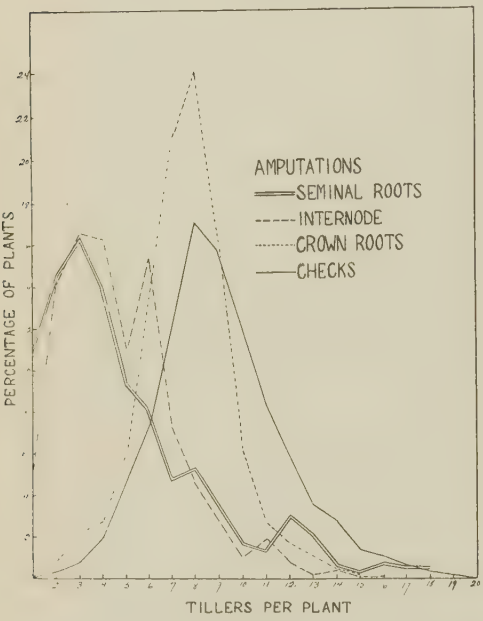


FIGURE 2.

Figure 2. Graphs showing the tiller distribution of injured and uninjured plants as determined from records at harvest time. Note the similarity between seminal and subcrown internode amputations.

FIGURE 3.

Figure 3. Groups of five representative plants in each case, from left to right,—Checks; seminal roots amputated on June 9; subcrown internode severed on June 13; and crown roots amputated on June 20.

The harvest records confirmed the early observations in that the seminal root amputations and subcrown internode operations caused considerably more injury than did the crown root cuts (see Figures 2 and 3). A similarity in reaction between seminal root and subcrown internode injuries was to be expected when the operations were made on or about the same date. In comparison, the crown root amputations caused distinct but only slight injury. Plants having their crown roots amputated matured slightly earlier than the checks, while in the other two operations there was a distinct tendency to lateness. This difference in ripening is reflected in the severity of stem rust infections. The later plants show a proportionately heavier attack than earlier ones. This was clearly shown in our plots last season (although not mentioned in the first paper) when the rust appeared somewhat later than it did this year. The early appearance and rapid spread of stem rust in 1930 interferred not only with observations on degrees of infection but

with accurate notes in relation to the maturity of the plants as well. There was a distinct difference in yield. It was thought advisable to have the yield data checked by Fisher's method of determining the significance of paired values. This showed in all cases that the odds were enormous that the differences between the amputations and checks were significant. In general the results were in good agreement with those reported in the first paper.

The Influence of Later Amputations

This test consisted of a study of the reaction caused by amputations of the seminal or crown roots at different periods after the plants had attained a fair size. Three rows were selected for seminal root amputations and three for crown root amputations. The seminal root amputations were made on June 23, July 7 and July 21. All the plants in one row were operated upon on each date. The crown root amputations were made on July 4, July 18 and August 1. The procedure was the same as in the seminal root operations. The development of the plants at the time of the amputations can be determined from Table 1.

Observations made shortly after the operations showed that there was distinct evidence of shock in the case of the first seminal root amputations. The plants wilted remarkably, were yellowish green in colour, and three or four inches shorter than adjacent check plants. Later amputations caused much less severe reaction, in fact damage was practically negligible for those dealt with on July 21. The first crown root amputations caused the plants to lose considerable colour; there were no symptoms of wilt. The height was slightly reduced. The most characteristic symptom revealed by the later cuts was the bleaching or general pre-maturity appearance. This was very pronounced after the operation of August 1st. Many of the tillers died. The notes obtained at harvest time are given in Table 3.

Table 3.—*Showing the average development and yield at harvest time of plants which had their seminal roots or crown roots amputated at different stages of growth. Also showing the records from uninjured plants growing on each side of the injured rows.*

Amputations and checks	Date of operation	Number of plants measured	Average height cm.	Average number of culms headed	Average number of crown roots	Average yield per plant grams	Yields in per cent of checks
Seminal roots	June 23	94	90.1	5.5	37.0	2.67	58.8
Checks		200	104.4	9.1	—	4.52	
Seminal roots	July 7	86	88.0	5.6	39.2	3.25	89.7
Checks		200	104.5	8.7	—	3.63	
Seminal roots	July 21	93	101.4	7.5	44.9	3.32	101.8
Checks		200	102.5	7.6	—	3.26	
Crown roots	July 4	89	87.0	5.6	10.0	3.30	77.7
Checks		200	104.4	8.9	—	4.24	
Crown roots	July 18	81	102.3	7.3	0.3	2.12	64.8
Checks		197	104.1	8.3	—	3.27	
Crown roots	Aug. 1	70	105.1	7.0	0.3	2.55	77.7
Checks		185	103.8	8.0	—	3.28	

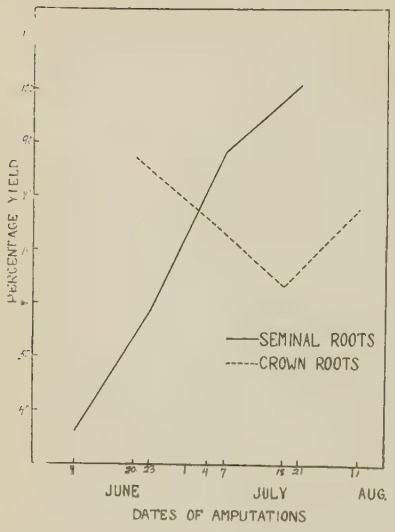


Figure 4. Showing the influence on yield when seminal roots or crown roots are amputated at different stages of the plant's development. The percentage yield is based on the checks in each case as 100%. (see tables 2 and 3).

The above results show clearly that the amount of injury, when yield is used as an index, depends upon the stage of development of the wheat plant at the time the roots are injured. It will be seen that mutilation of the seminal root system early in the season is distinctly more injurious than later amputations. Crown root amputations, on the other hand, have an opposite trend; the earlier injuries caused less damage than the later ones (Figure 4). When, however, the plants approach maturity, injuries to the crown root system, although harmful, are not so marked in effect as injuries received slightly earlier. The plants do react, nevertheless, by a reduction in the number of culms and general bleaching. The lack of normal colour indicates a decrease in photosynthetic activity and gives the plants a mature appearance distinctly earlier than usual. Weaver (*3*) found that there was little new root development three weeks previous to maturity.

The Removal of Crown Roots at Weekly Intervals

This experiment was performed in an endeavour to determine the influence of continuous crown root amputations at regular periods so that the plants would be dependent almost entirely upon the seminal root system. The plants of four rod rows were used. On June 16 when the plants had reached a fair size (see Table 1) all the crown roots were amputated. This operation was repeated on June 23, July 1, July 8 and July 14. The plants had to be supported to keep them from falling over and breaking off. Occasionally the subcrown internode was severed by accident and for other similar reasons a large percentage had to be discarded when the final notes were made. The number of plants operated upon and the number of roots removed each week are shown in Table 4.

Table 4.—*Showing the average number of plants of four rod rows which had their crown roots amputated each week over a five week period commencing June 16, and the average number of roots removed each time.*

Date	Average number of	
	Plants operated upon	Roots cut off
June 16	99.5	8.9
" 23	97.0	10.3
July 1	95.5	16.9
" 8	87.0	13.9
" 14	82.7	6.5
		56.5

The capacity of the plants to produce new crown roots is well illustrated in the above table. There were several small showers of rain throughout the period of the experiment which undoubtedly had a beneficial influence. Regardless of this, however, it is but normal for crown roots and the tillers to increase as the plant grows. Once ripening processes set in, there was a decrease in the number of new crown roots produced. Here in many cases the roots appeared to have an excessive growth of laterals. It will be seen that the total number of roots produced approximates the total recorded for uninjured check plants at harvest time (see Table 1).

On July 5, a few days after the third operation, observations were made on the general appearance of the plants. They were found to be distinctly stunted and the basal leaves were noticeably lacking in colour, being of a yellowish green. The most vigorous tillers, however, were in the shot-blade stage. The harvest notes revealed the general injurious effects of repeated amputations as shown in Table 5.

TABLE 5. *Showing the average development of plants which had their crown roots amputated at weekly intervals from June 16 to July 14 inclusive.*

Number of plants measured	Average height cm.	Average number of culms	Culms ripe %	Average number of crown roots	Average yield per plant grams
67	71.6	6.6	57.5	0.36	1.6

Figure 5. Showing typical specimens of plants which received severe crown root amputations.

The above table shows the severity of the injury especially as reflected in the yield. There appeared to be the usual tendency for crown root amputations to hasten maturity. Undoubtedly if the stem rust attack had not interfered to some extent with observations, the percentage of ripe culms would have been higher. The rapid bleaching and premature ripening of many of the tillers, likewise, made observations on normal maturity very difficult. Although the plants were largely dependent upon the seminal root system, they were not entirely so, as each set of new roots undoubtedly functions to advantage for a while. At harvest time very few crown roots were found (Figure 5).

DISCUSSION

The first part of this work substantiates pretty well the results obtained from a similar experiment last season. When the seminal root system or subcrown internode is

injured during the very early stages of development the reaction is distinctly shown in a reduction of yield, height and tillering as well as a tendency to lateness in ripening. Early crown root amputations on the other hand are not so harmful but have a tendency to induce prematurity. The reduction in the number of tillers and their distribution is similar for seminal root and subcrown internode amputations. In the case of crown root cuts, however, there is a comparatively slight deviation from the normal in this respect. The reduction in culms is at least in part responsible for the reduced yield. If under field conditions these organs for any reason cease to function, one has a right to expect some degree of the reactions mentioned above, thus bringing about irregularity in ripening and consequently an irregular sample of grain with a probable decrease in yield and grade. A virulent fungous infection near the seed might readily destroy the seminal roots, or on the other hand the slender subcrown internode might be a seat of infection bringing about equally harmful results.

It is quite possible in some cases that reductions in yield and grade considered as caused by heavy stem rust infections are primarily the result of root affections which retard the plants and predispose them. In Saskatchewan the damage caused by stem rust is greatly influenced by the difference of a week or so in the ripening of the crop. Vanterpool and Ledingham (*2*) in discussing the "browning" root rot of wheat mention that affected plants are late in maturing. It is hardly necessary to point out the significance of delayed ripening also from the standpoint of frost injury. Until further knowledge is gained of the reactions caused by root diseases, their real importance will often be submerged by the more evident symptoms resulting from other factors.

Later injuries to either root system caused reactions which were of particular interest. In the early stages of growth the seminal roots appear to dominate. They constitute the main absorbing system. Thus one might expect some unfavorable results if the seminal roots were injured at any time prior to mid-season, or in this case until after seven or eight weeks from the date of seeding. There appears to come a time about mid-season, however, when the crown root system is of equal importance. Injuries to either group at this transition point have about the same effect. From this time on, however, the crown roots dominate. They become or can become the principal absorbing system. After this period amputations of the seminal roots show very little injury, whereas amputations of the crown roots are highly deleterious. Finally the ripening processes set in and further amputations become less harmful, although undoubtedly interfering somewhat with the yield and grade. Here again the rust attack made observations somewhat inconclusive. It seems then that both root systems have their part to play and that both are essential. It is very likely that injuries to the seminal root system during the seedling stage will be reflected in the subsequent development and productivity. It is very probable that under average conditions the activity of the seminal system will decrease as the season advances. This may take place gradually and without any apparent ill effects. The crown root system because of its prolific new root formation can withstand considerable damage under favourable conditions. When it is the chief absorbing system, however, injuries will probably cause pre-maturity with a decrease in yield and grade. Under field conditions when the roots are attacked by fungi both the seminal

and crown systems might be involved, as well as the subcrown internode. This would result, in all likelihood, in very complex reactions, such as are prominent in severe root rot attacks. In most cases the symptoms of diseases of the root system are rarely clear cut. They may range from imperceptible reactions to complete mortality. For instance, a slight infection of the seminal system might, with increasing soil temperature, lead to a severe infection of the entire crown root system later in the season. Complications are thus ever likely to arise which render a critical diagnosis difficult.

The third phase of the investigations reveals that the growth of the wheat plant can be supported almost, if not entirely, by the seminal root system. Although many new roots were formed to replace those cut off and in all probability were functional for a time, yet the seminal root system was the main support throughout. It seems probable that this first root organization (frequently referred to as temporary roots) can take over, at least in part, the functions of the crown root system when that system is interrupted in any way. The remarkable power of the wheat plant to replace crown roots which are destroyed is well supported by evidence here.

The above experiments deal only with mechanical injuries and their reactions. The whole phase of physiological reactions attendant upon infections offers wonderful possibilities for investigation. The part played by each root system and the different reactions which result from injuries to either are of particular interest in the interpretation of diseases of the roots. One must consider the complete rhizosphere. The two root systems occupy normally a rather large volume of soil. According to Weaver (*3*) the seminal roots penetrate to the greatest depth while the crown root organization is massed nearer to the surface of the soil. This growth habit and all factors which may influence it must be kept in mind when studying diseases of the root system of wheat.

Summary

1. Seminal root amputations during the seedling period are injurious as indicated by a reduction in yield and a tendency towards delayed maturity. The severance of the subcrown internode during this time is likewise harmful. Crown root amputations on the other hand cause little reduction in yield but appear to encourage the maturing processes.

2. During the seedling period and up to about mid-season the seminal roots appear to be most important. Amputations of these cause severe injury early in the season with decreasing severity as the operations are made later. They constitute during this period the chief absorbing system. The reactions caused by crown root amputations are quite the opposite, with the severest injury after mid-season, when apparently these roots become the principal absorbing system. Crown root amputations, however, just before maturity are less injurious than those made just previous to that time. At mid-season the seminal and crown root systems are of equal importance.

3. The potentialities of the wheat plant to replace amputated crown roots are well demonstrated when crown roots are cut off at weekly intervals. Furthermore the plant may produce seed when dependent almost entirely upon the seminal roots.

4. The interpretation of some of the results in their application to a better understanding of root diseases is briefly discussed.

ACKNOWLEDGMENTS

The writers wish to acknowledge the assistance of Mr. W. G. Sallans who helped with the work throughout the summer and also they wish to thank Mr. T. Stevenson for checking biometrically some of the yield data.

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CURRENT PUBLICATIONS

DECOMPOSITION AND MOVEMENT OF HERBICIDES IN SOILS, AND EFFECTS ON SOIL MICROBIOLOGICAL ACTIVITY AND SUBSEQUENT CROP GROWTH. W. E. Bowser and J. D. Newton. Canadian Journal of Research, Vol. 8, No. 1. January, 1933.

Experiments were conducted to determine the residual effect of sulphuric acid, copper sulphate, sodium chlorate, barium chlorate and sodium dichromate on three typical Alberta soils. No problem of residual effect was found with the two leaf sprays, sulphuric acid and copper sulphate. Sodium chlorate will remain toxic over a period of about two years, depending mainly on the organic matter content of the soil and the amount of leaching that takes place. The distance that the chlorate will leach down into the subsoil will depend on the amount of rainfall and the character of the soil. As soon as the chlorate is leached out or is reduced the soil returns to its normal productive power. Sodium dichromate decomposes very rapidly in the soil. It has a depressing effect on nitrification and on the activity of the soil micro-organisms. However, there is practically no residual effect from the use of sodium dichromate on soils of medium to high organic matter content.

SOILS OF SOUTHERN ONTARIO

A Field and Laboratory Study of Some of the Major Soil Series of Southern and Eastern Ontario[1]

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[Received for publication June 2, 1932]

Introduction

This study is based mainly upon the findings of a detailed soil survey in several counties in south-western Ontario and one county in eastern Ontario, along with a reconnaissance survey of some other parts of southern and eastern Ontario. Use has also been made of reports of similar work done elsewhere and of geological and climatic data available for the region.

Many factors have influenced and are influencing development of our soils. The parent soil material or the disintegrated mass of rock particles, etc., from which the soils are formed, has an influence but not a paramount influence, because we have extremely different soils developed or developing from similar parent soil material, and similar soils developed from very different parent soil material. Climate has an important influence but again we have very different soils developed from similar parent material in the same climate. Vegetation has an important influence, as well as topography and drainage and so on. Some of these factors are inter-dependent, one upon the others.

Major Soil Divisions of the Great Lakes Region

The Soil Survey Branch of the United States Bureau of Soils has worked out a broad classification of the soils of the United States as described by Wolfanger in his book, "The Major Soil Divisions of the United States," and their boundaries can be projected into the southern part of Canada. This classification is based upon the characteristics of the soils themselves as normally developed in smooth, well-drained regions, undisturbed by erosion or deposition. Associated with these normal "mature" soils of any region there may be "immature" or "abnormal" soils due to the effects of poor drainage, erosion, deposition of new sediments, etc. In this classification there are two main divisions, namely:

(1) Those soils which accumulate lime-carbonate in some horizon in the solum (a term used by pedologists to indicate the soil exclusive of its underlying parent material) in higher percentage than in the parent soil material.

(2) Those soils which do not accumulate lime-carbonate in any horizon in the solum.

Dr. Marbut, Chief of the Soil Survey Branch of the U. S. Bureau of Soils, has suggested the terms *Pedocals* (soils with calcium carbonate accumulations) for the lime-accumulating division, and *Pedalfers* (soils with iron and alumin-

[1] Contribution from the Department of Chemistry, Ontario Agricultural College. Part of a paper given at the Soils Section of the C. S. T. A. Convention at Guelph in June, 1931.

[2] Specialist in Soil Surveys.

ium accumulations) for the non-lime-accumulating division. The mature soils of the latter are characterized by a horizon from which sesquioxides (most markedly those of iron and alumina) have been extracted and a horizon in which they have accumulated.

The Pedocals have developed under conditions of low annual precipitation (below approximately 25 inches annually), insufficient to maintain a continuous downward movement of moisture to an indefinite depth. The natural vegetation is typically grasses, although it may include some plant communities of savannah brush and shrub. These soils occupy most of the Great Plains regions of the Central Western States and the Prairie Provinces east of the Rocky Mountains.

The Pedalfers have developed under conditions of higher annual precipitation (approximately between 25 and 60 inches annually) or sufficient to maintain a permanent moist condition of the soil and parent material down to the permanent water table. The natural vegetation is typically forest. These soils occupy all the eastern half of the United States and southern Canada, as well as numerous smaller areas in the West.

Each of these large divisions of soils is sub-divided into four or five groups and it is with the northern pedalferic groups (the Podzols and the Grey-brown Forest Soils) that we are particularly interested, in this discussion. There is no distinct or definite boundary between the various groups but rather a gradual transition from the one to the other. The podzols occupy, in general, the region north of a line drawn from the south-eastern part of Manitoba down across the north-eastern part of Minnesota, the north central part of Wisconsin, central Michigan, the southern end of Georgian Bay, the upper part of the St. Lawrence River, dipping southward around part of the Adirondak region of New York, northward around the Lake Champlain region and across through Vermont, New Hampshire and Maine to the south-western part of New Brunswick. There are some areas of well-developed podzols south of this general line and some areas of grey-brown forest soils north of it, but this makes a good general division between the two large groups of soils.

Surface Geology of the District

The upper rock formations over Southern Ontario south of a line approximately from Southern Muskoka to Kingston and over Eastern Ontario, east of a line curving westward from Ottawa around to Brockville, are of the Devonian, Silurian and Ordivician Ages and are mostly limestones. The upper rock formation of the area lying between these two lines and northward is of the pre-cambrian age or what is known as the "Canadian Shield" and is made up largely of igneous and metamorphic rocks.

All of this area has been glaciated. Most of the former area is covered with a fairly thick mantle of glacial till, outwash material and lake sediments, most of which contain a fairly high percentage of limestone in their unleached condition. The latter, or "Canadian Shield" Area, has very little covering, much of the bed rock being exposed at the surface.

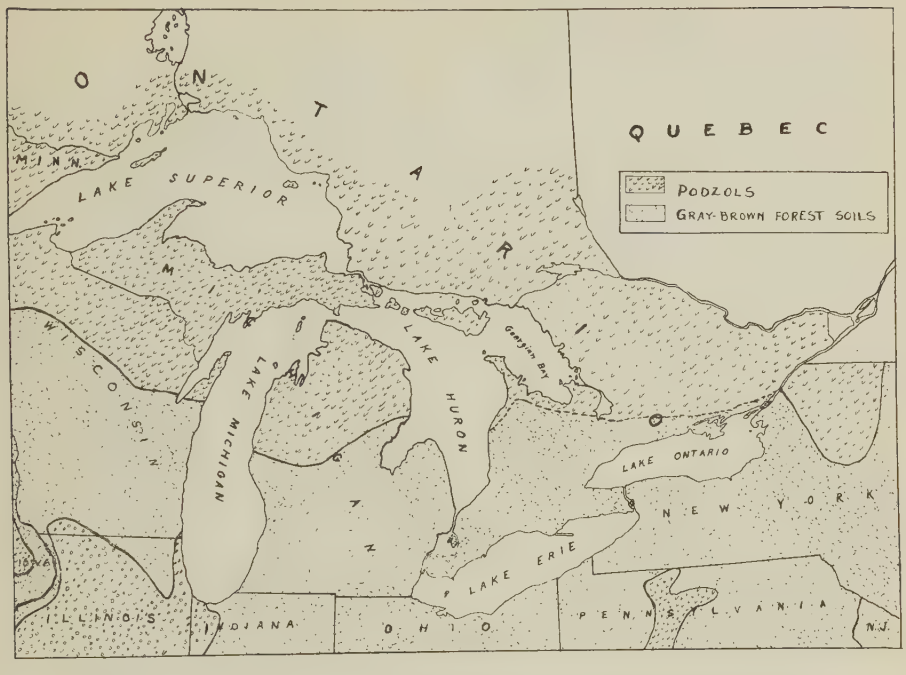

Figure 1. Sketch Map showing the major soil types of the Great Lakes region.

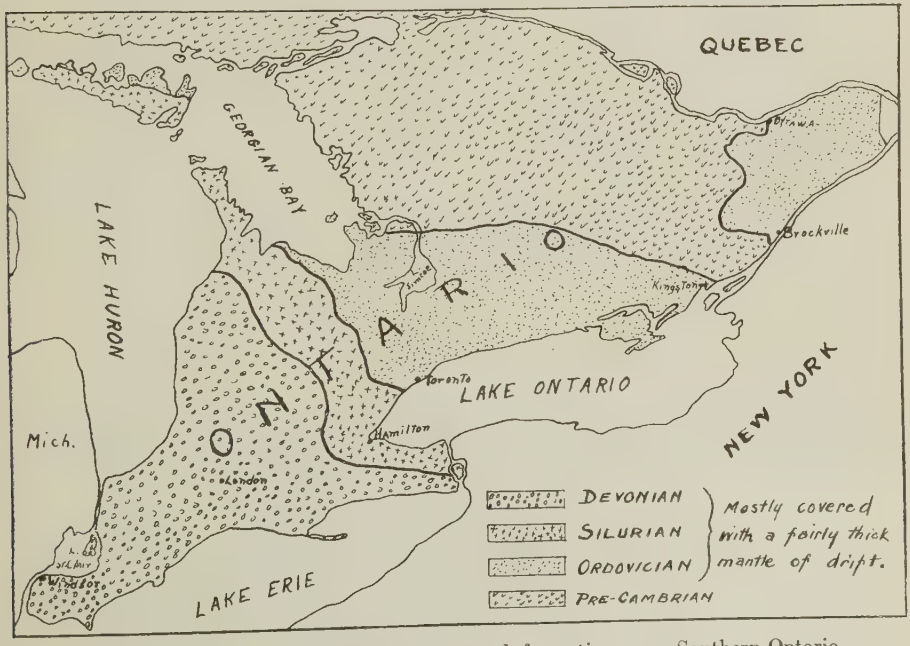

Figure 2. Sketch Map showing the upper rock formations over Southern Ontario.

Climate

This part of Ontario lies between 42° and 46° north latitude. The mean annual temperature for the area is 44° F., with a range from 46° F. in the southern boundary to 41° F. at Parry Sound in the North. The normal annual precipitation varies from 25 inches in the south-western part to 39 inches in the north and eastern part.

Vegetation

The original vegetation of this region was forest. That of the southern part was made up largely of hardwoods. North of this there was a mixed hardwood and coniferous forest, shading off into the coniferous forest in the north.

Descriptions of Representative Soil Series

A. Podzols. Podzol soils are developed in only a small proportion of area under discussion and mainly in the sandy areas. They are characterized by the following general profile: ½ to 2 inches of brownish or black leaf mold and other organic debris (A_0 horizon); 1 to 3 inches of dark greyish mineral soil (A_1 horizon); 2 to 6 inches of greyish white friable mineral soil (A_2 horizon); 6 to 10 inches of dark rusty or reddish brown, very compact mineral soil (B_1 horizon); 10 to 20 inches of yellowish brown, somewhat mottled, slightly compact mineral soil (B_2 horizon) underlain by the greyish unweathered or slightly weathered parent soil material. The A_0 and A_1 horizons are usually mixed together where the soil has been pastured and tramped.

The organic matter content of this soil is high in the shallow A_0 and A_1 horizons, very low in the A_2 or leached horizon, increases considerably in the B_1 horizon and then decreases with depth.

The profile is strongly acid down to and including the B horizons, with the maximum degree of acidity in the A_2 or B_1 horizon.

The Rubicon series is the most common representative of podzol soils in the areas mapped. It is developed on sandy outwash material in imperfectly drained locations. The A_2 or leached horizon is very conspicuous in freshly exposed banks. It is mostly quartz sand. In places the B_1 horizon is indurated to form irregular chunks of hard-pan. An analysis (Table 1) of a virgin sample taken from Grenville County will give some idea of the chemical composition of this soil.[3]

B. Grey-brown Forest Soils. The major profile development in the well-drained, smooth upland soils of Southern Ontario is represented by the Miami, Haldimand, Fox and Bellefontaine series. These soils are typical of the grey-brown forest soils. They are characterized by the following general profile; ½ to 1 inch of leaf mold and organic debris (A_0 horizon); 3

Description of Plate I on opposite page.

Upper left—Roadside cut showing the upper part of the profile of Rubicon sand. Upper right—Cross section showing the profile of Haldimand silt loam. Center—The profile of Bellefontaine loam. Lower The flat topography of Clyde soils showing artificial dredge cuts which are essential for drainage. The soil is drained by tile into the lower ditch and the water is pumped from there into the upper large dredge cut which carries it out to the lake.

[3] The analytical work was done by Mr. H. M. Scollie and other members of the Soils Branch of the Chemistry Department, Ontario Agricultural College.

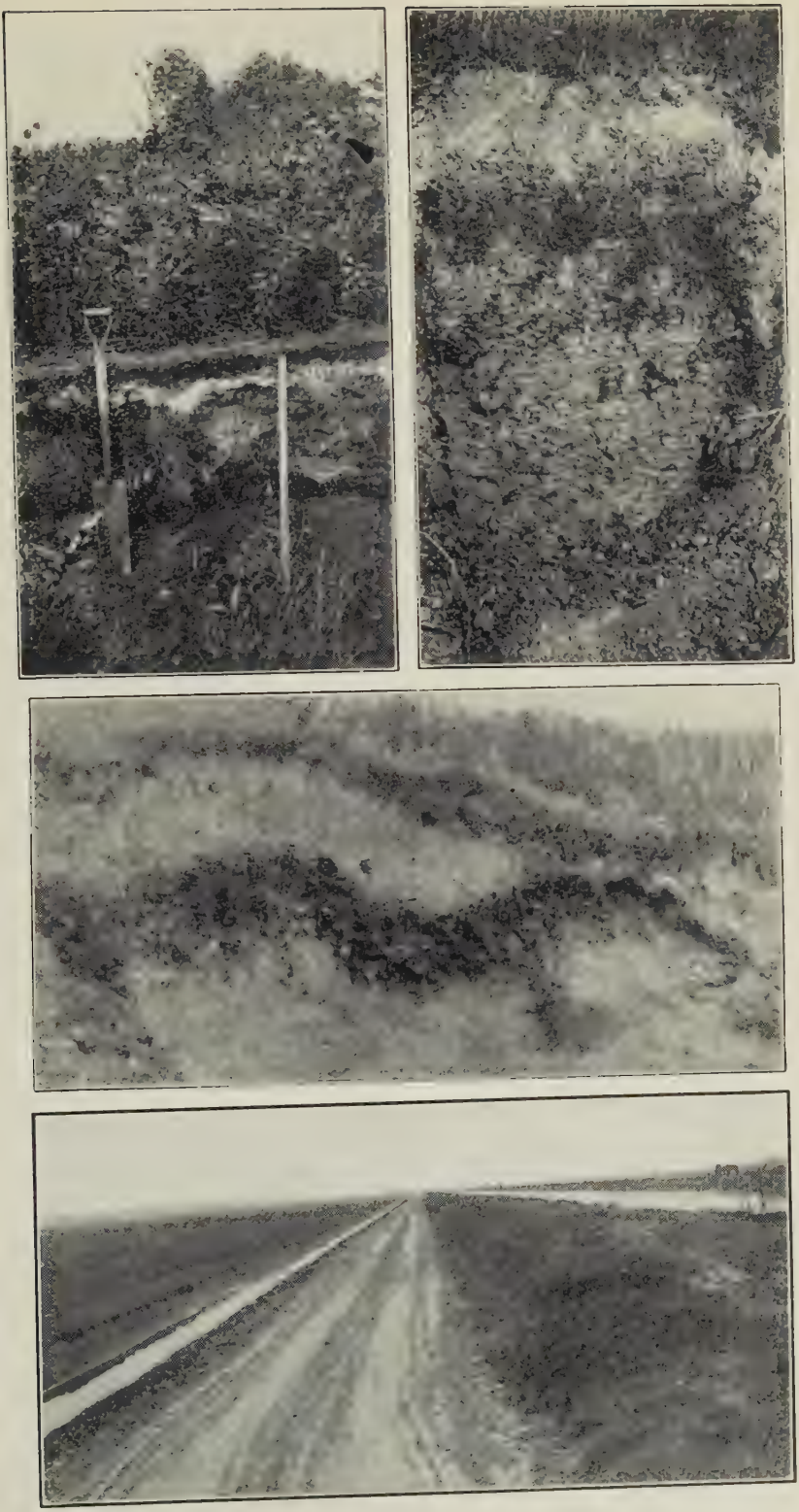

Plate 1. See foot of opposite page for explanation.

TABLE 1.—*Chemical analysis* of rubicon sand. Analysis of 1 virgin profile.*

Horizon	A_1	A_2	B_1	B_2	B_3	C
SiO_2	52.24%	78.56%	63.98%	71.14%	74.32%	74.12%
Sesquioxides	5.87	3.07	6.45	4.21	4.34	4.93
Ca O	2.57	1.28	1.11	2.95	3.34	3.34
P_2O_5	.18	.05	.04	.06	.10	.03
Org. C.	9.83	.21	3.05	.46	.13	.05
Org. Matter	16.96	.37	5.26	.79	.22	.09
Loss on Ignition	22.20	.68	10.80	1.96	1.16	.56
N.	.74	.02	.12	.02	.01	—
pH	5.35	5.02	4.77	5.47	5.67	5.77

* Acid digestion following official methods, was used to determine silica, sesquioxides, calcium, magnesium and phosphorus. Nitrogen was determined by the Kjeldahl method and organic carbon by the modified chromic acid and hydrogen peroxide method. Organic matter was determined by calculation from the organic carbon (C x 1.724) as well as by the roughly approximate "Loss on ignition" method. The reaction was determined by the quinhydrone electrode.

TABLE 2.—*Chemical analysis of Bellefontaine loam. Average analysis from 5 virgin profiles.*

Horizon	A_1	A_2	B	C
SiO_2	80.2%	85.5%	77.6%	63.3%
Sesquioxides	6.98	7.11	12.52	10.93
Ca O	1.38	.86	1.59	16.12
MgO	.33	.42	.55	.76
P_2O_5	.122	.091	.146	.121
Org. C.	3.16	.57	.55	.43
Org. Matter	5.45	.98	.89	.77
Loss on Ignition	9.20	2.63	1.71	1.11
N.	.33	.06	.06	.03
pH	7.48	7.25	7.72	8.13

to 5 inches of dark greyish brown mineral soil (A_1 horizon); 6 to 40 inches of light greyish or yellowish brown, friable soil (A_2 horizon); 3 to 16 inches of reddish brown, compact soil (B horizon); and a substratum (C horizon) of greyish, unweathered, parent material. The A_2 horizon is quite thin in the heavy soils but is much thicker in the lighter soils, while the B horizon is quite thick in the heavy soils and much thinner in the sandy soils.

The Fox series is a good representative of the lighter soils of this group. It is developed from sandy or gravelly material and is underlain by stratified sand and gravel. The Bellefontaine series is developed from coarse, unassorted morainic material. It varies in texture from a sandy loam to a loam

and contains many boulders of varying sizes. The Miami series is developed from finer or heavier textured morainic material and varies in texture from a loam to a clay loam. It also contains numerous stones and boulders. The Haldimand series is developed from lake sediments and varies in texture from a silt loam to a clay loam. It contains very few stones or boulders.

Table 2 shows the average results of a chemical analysis of 5 virgin profile samples of Bellefontaine loam, which is typical of the mature grey brown forest soils of this region with the exception that it has a higher pH value in the upper layers than in many of the other series.

A few of the outstanding points of the chemical analysis may be noted as follows. In the grey-brown forest soils, represented by the Bellefontaine loam, there is a high silica content in the A_2 horizon, a distinct accumulation of sesquioxides in the B horizon and a decrease in organic matter, carbon and nitrogen from the surface downward with approximately the same amounts in the A_2 and B horizons. In the podzols as represented by the Rubicon sand, there is a still higher silica content in the A_2 horizons, as compared to the A_1 and B_1 horizons, not as great an accumulation of sesquioxides in the B horizons and a distinct accumulation of organic matter, carbon and nitrogen in the upper part of the B horizon.

C. Immature Soils due to the Effects of Poor Drainage. The Brookston and Clyde series are representative of the poorly drained heavy soils. They have dark surface soils and highly mottled but poorly drained subsoils and are nearly flat in topography. They are usually neutral to slightly alkaline in reaction and have a high organic matter content. They differ mainly in one respect. The Clyde soils have a much deeper and darker surface soil than the Brookston.

The Berrien and Granby series are representative of the poorly drained sandy soils. Berrien soils have slightly rolling or undulating topography and the surface soils are fairly well drained but the lower layers of the soil are highly mottled and are underlain by grey water-soaked sand. This soil has a fairly low organic matter content and is strongly acid in the surface layers.

Granby soils have a deeper and darker surface soil and are underlain with grey water-soaked sand, often with some mottling just below the surface soil. This soil is often locally known as having a "quicksand bottom". This soil has a high organic matter content and is neutral to alkaline in reaction.

Summary

1. An outline of the major soil divisions of the Great Lakes Region is given, as worked out by the Soil Survey Branch of the U. S. Bureau of Soils and correlated with work done in Southern Ontario.

2. The surface geology, climate and natural vegetation are briefly discussed.

3. Some of the predominating soil series of Southern Ontario are briefly described and correlated.

4. Chemical analyses are given for profiles of soil representative of the podzols and grey-brown forest soils which are the two major soil divisions in Southern Ontario, according to this outline.

TRANSMISSION OF STREAK AND MOSAIC DISEASES OF TOMATO THROUGH SEED. No. II

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[Received for publication November 26, 1932]

In a previous paper (*1*) the authors presented experimental evidence which demonstrated that although mosaic and streak diseases of tomato may be carried in the seed, nevertheless the seed from mosaic or streak plants under identical environmental conditions sometimes may produce plants with no mosaic or streak symptoms. The present paper presents additional evidence concerning this latter point.

We are particularly grateful to Mr. O. J. Robb of the Vineland Experimental Station for supplying us with fruits from specially selected mosaic plants.

The objects of this investigation were, first, to ascertain whether the virus was present in seeds from green, as well as ripe fruits, and, second, to find out if the seeds from each truss of a mosaic plant were equally capable of producing mosaic when their crushed embryos were inoculated into healthy tomato plants.

Experimental

All inoculations recorded in this paper were effected by means of crushed embryos as described in a previous paper (*1*). All tomato plants inoculated with this crushed embryo material were of our special selection of Grand Rapids variety that has remained free from mosaic for the last five crops. Forty check plants of this Grand Rapids stock were maintained throughout these inoculation tests and in no case did a check plant show mosaic symptoms.

To ascertain whether or not the virus of tomato mosaic is present in seed from green fruits, several tests were made by inoculating healthy Grand Rapids plants with the crushed embryos of seed taken from green and ripe fruits of Manx Marvel and Grand Rapids varieties, which were affected with mosaic. In all, 48 tomato plants were inoculated with the crushed embryos of seeds from green and ripe fruits resulting in all cases with from 50 to 75% mosaic. The incubation period was approximately 15 days. These results demonstrate that seeds from green, as well as ripe fruits taken from infected plants, contain the infective virus.

In an endeavour to ascertain whether or not the seed from each truss of a plant may carry the mosaic virus, crushed embryos of seed from each truss of individual affected plants were used as sources of inoculum. It was found that, though, as a rule, all the seed from a mosaic plant carried the infective virus, yet occasionally the seed from certain trusses either failed entirely to produce mosaic, or the percentage obtained was small in comparison to that obtained from other trusses of the same plant. For instance, the crushed embryos from the second truss of a Manx Marvel plant failed to produce

[1]Senior Pathologist-in-charge and Plant Disease Investigator respectively. A contribution from the Division of Botany, Experimental Farms Branch, Dominion Department of Agriculture, Ottawa, Ontario.

mosaic symptoms, whereas the crushed embryos of seed from all the other trusses up to the eighth truss, produced from 50 to 100% mosaic. In all, 72 plants were inoculated in connection with this test, and 20 uninoculated plants of the same parentage as the inoculated plants remained healthy throughout the experiment. On the other hand, the seed of every truss from other plants affected with mosaic was capable of inducing mosaic symptoms. It should be pointed out that these inoculation tests were carried out under identical environmental conditions.

It was also desirable to ascertain whether or not all mosaic plants, at all times, readily transmit the virus to their seed. To this end, crushed embryos of seed from many different mosaic plants were inoculated separately into healthy Grand Rapids tomato plants. The crushed embryos of seed from 3 different mosaic plants failed to produce mosaic, while the crushed embryos of seed from 5 other mosaic plants produced definite mosaic symptoms, when inoculated into healthy tomato plants, under similar environmental conditions. These results clearly demonstrate that though the virus of tomato mosaic is generally transmitted to the seed, yet there are occasions when apparently it cannot be demonstrated. The cases recorded in the literature where seed from mosaic plants gave rise to 100% healthy plants may possibly be explained on this basis. Nevertheless the experimental evidence recorded here, accompanied by the fact that by seed selection we have been able to avoid mosaic in our greenhouse crops, clearly points out that seed from mosaic plants for the most part produces progeny with mosaic tendencies. It is therefore a fundamental precaution to select seed from plants free of mosaic and thus build up a strong, vigorous, healthy stock.

In order to compare the percentage of mosaic resulting from inoculations with the crushed embryos of seed from mosaic plants, with the percentage of mosaic resulting from planting seed taken from mosaic plants, a quantity of seed from a single truss of severely affected mosaic plants was divided into two equal parts. One part was planted in sterile soil, while the embryos were extracted from the other part and inoculated directly into healthy plants. The direct inoculation produced over 60% mosaic in 15 days time (90 plants inoculated), while the planted seed produced only 6% mosaic plants after one and one-half months time (145 plants planted). No further mosaic showed up in these plants though they were kept an additional month. It has always been our experience that though we can artificially produce as high as 100% mosaic by means of inoculations with crushed embryos of seed from mosaic plants, yet very seldom indeed have we had more than 12% mosaic from seed from mosaic plants, when such seed was planted and the resulting plants allowed to grow to maturity. This experience may well be regarded as indicating the influence of environmental factors affecting the development of mosaic under the conditions referred to.

Conclusions

The further evidence submitted in this paper demonstrates:

(1) That mosaic is extensively transmitted through the seed. This has been proved experimentally by inoculating healthy plants with crushed embryos from mosaic plants, and by growing to maturity the progeny from seed collected from mosaic plants.

(2) That the infective principle may be present in seeds from green as well as ripe fruit of affected plants.

(3) That the seed from certain trusses of a mosaic plant may produce progeny which develop mosaic symptoms, while the seed from another truss of the same plant may produce healthy plants under similar environmental conditions, a phenomenon not yet understood.

(4) That mosaic produced by inoculating healthy plants with the crushed embryos of seed from mosaic plants is contagious and apparently similar in all respects to tomato mosaic as commonly known.

(5) From the standpoint of prevention and control, growers of greenhouse tomatoes are urged to build up their own seed supply by means of a rigid selection from, and isolation of, healthy plants.

REFERENCE

1. Berkeley, G. H. and G. O. Madden. Transmission of streak and mosaic diseases of tomato through seed. Scientific Agriculture *13*: 3; 194-197. November 1932.

CURRENT PUBLICATIONS

GARDENS OF THE MACKENZIE, W. D. Albright. Reprinted from the Geographical Review. Vol. XXIII, No. 1. January, 1933.

Mr. Albright, who is superintendent of the Dominion Experimental Sub-Station at Beaverlodge, Alberta, has written a very interesting account of the agricultural possibilities of the country north of the Peace River district. Cultivation is mainly confined to gardens which do well on account of the long hours of sunshine and in spite of the fact that the frost may be only a few inches down. This account appeared in the official organ of the American Geographical Society and is well illustrated with photographs by the author and by the Royal Canadian Air Force.

NATURAL CROSSING WITH WILD OATS, *AVENA FATUA*

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[Received for publication June 10, 1932]

In the published literature on natural crossing in oats, the writer has seen only one reference (*1*) to the occurrence of naturally crossed hybrids between *Avena sativa* and *Avena fatua* when the parents were definitely known. Many records are available in the literature on this subject, however, that indicate a considerable range of natural crossing in oats, depending largely on variety and environment.

Many of the earlier workers differed in their opinion with regard to the extent of natural crossing in oats and it seemed quite generally accepted that oats crossed naturally very infrequently. More recent work, however, has shown quite definitely that oats do cross naturally and that the problem has become of extreme importance particularly to the plant breeder, and to a lesser degree to the grower of high grade seed.

For the purposes of this paper, it seems unnecessary to summarize or list the literature on this subject since the more recent references have been cited by Harrington (*2*) in a paper appearing in *Scientific Agriculture*.

Material and Methods

The work reported below was instituted in 1930 at Ottawa as the result of an observation made in 1929 by the writer in a plot of elite stock seed of a prominent seed grower in Alberta. There appeared in this plot of Banner oats a small percentage of plants having black or dark coloured lemmas some of which appeared to be intermediate between *A. fatua* and *A. sativa* with regard to basal articulation and awn development. Some of this dark coloured seed was brought to Ottawa and grown in the greenhouse during the winter of 1929-30. Segregation occurred in this material which indicated the possibilities of *A. fatua* and *A. sativa* parentage.

As a result of these observations, a definite natural crossing project was outlined in the spring of 1930 to determine the possibilities of natural crossing between *A. fatua* and *A. sativa*. About 400 seeds of Alaska (*A. sativa*)were spaced in a block 10 x 6 feet, the rows being 7 inches apart and the seeds 2 inches apart in the rows. In the centre of this block, three spaces 1 sq. foot each were seeded to wild oats, *A. fatua*, the seed of which was kindly supplied by Mr. Davidson, Dominion Experimental Farm, Indian Head, Saskatchewan. During the course of the growing period, it was noted that the Alaska plants would probably flower some time ahead of the wild oats and, therefore, certain of the Alaska tillers were clipped off leaving only those that would flower at approximately the same time as the wild oats.

At harvest all the Alaska plants numbering 357 were pulled and all the seed from each of these plants was sown in the field in 1931. From the 28,800 plants thus produced, twenty-eight were found that carried the dark coloured lemma and these were grown during the winter of 1931-32 in the

[1] Cerealist.

greenhouse. Without exception, these plants segregated for colour of lemma, awns and basal articulation and it would seem, therefore, that under the conditions of this experiment, crossing between *Avena sativa* and *Avena fatua* takes place naturally, the actual amount obtained being 0.1%.

Wind as a Factor in Natural Crossing

Further evidence of natural crossing in oats has been obtained in some special work outlined particularly to show the distance that pollen is normally carried by the winds. In this project, Banner oats was seeded in rows 5 feet long and 7 inches apart, the rows running north and south. There were 83 rows in all seeded in this direction, the centre 3 rows of which were a black variety under the name of Old Island Black. Another series of 83 rows with 3 rows of the black variety in the centre was seeded at the same time in the opposite direction—east and west. Banner and Old Island Black were chosen for this work for the reason that the two varieties mature at approximately the same time.

At harvest, each row of Banner was threshed separately, and numbered from the black variety in each direction. The following spring, bulk seed was taken from the threshed sample of each row and seeded in a rod row plot. At maturity the number of plants present with dark coloured glumes in each rod row plot was recorded.

The results showed that in three of the 40 rows east of the Old Island Black, natural crossing had been affected. Since there were 960 plants in this area, 0.31% of the plants had received pollen from the black parent. In checking up the location of the rows in which natural crossing had taken place, it was noted that the black segregates had been found in the first, second and fifth rows immediately east of the black parent. Since the rows were 7 inches apart, the greatest distance showing evidence of pollen having been carried by the prevailing westerly wind was approximately 4 feet.

In the north-south series of rows, a black hybrid was found in only one row, this row being the one nearest the black parent on the south side. Again, on the basis of 960 plants in the block, extending north and south on either side of the black parent, the one black plant found would give a percentage natural crossing of 0.10. The north wind, therefore, had considerably less effect in producing natural crossing than did the west wind. No hybrids were found in either of the blocks north or west of the black parent. These data are interesting particularly from the standpoint of plant breeders and those endeavouring to produce elite stock seed and emphasize the importance of prevailing winds in the problem of natural crossing.

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A SIMPLIFIED METHOD FOR CLEANING MILKING MACHINE RUBBER PARTS

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Various methods have been described whereby the milk tube system of a mechanical milker may be kept in a sanitary condition. In every case the necessity for the use of several gallons of hot water in the cleaning of the machines after each milking has been stressed. Unfortunately, few farms are equipped to supply such quantities of hot water, and even when so equipped the fuel cost involved is a serious matter, especially with present prices for milk and cream. Consequently many farmers are content to rinse the machines with cold water to remove most of the milk residue, and to rely upon a so-called "sterilizing" treatment to keep down the bacteria. Although entirely unsatisfactory from the standpoint of physical cleanliness, this method is sometimes effective for a time in controlling bacterial contamination. Sooner or later, however, the accumulation of fat causes deterioration of the rubber parts, bacteria breed undisturbed in the crevices formed, and abundant trouble ensues. Not infrequently the farmer becomes disgusted and returns to hand milking, losing the money invested as well as the labour-saving advantages of mechanical milking (*5*).

Parfitt (*4*) has recommended the use of a weak lye solution for well washed milking machine tubes, as this method avoids the troublesome deposit of calcium phosphate, etc., appearing on the rubber when chlorine compounds are employed with hard water. In order to confirm Parfitt's results, studies on lye solution were commenced at the Central Experimental Farm in August 1930. A summary of the data from five series of tests appears in Table 1. In the first series all machines were treated with lye solution for a period of several months. In view of the satisfactory counts obtained, a second series was commenced in which comparative studies were made of lye and hypochlorite solutions. In both these series the machines were suction washed at the barn, using first a pailful of cold water, then a similar quantity of *hot* water containing washing powder, for each pair of units. In all five series the milk tube systems were then placed on solution racks and filled with the solution in question. The solution was drained out just before assembling the machine at the next milking, and the tubes were not rinsed or further treated in any way. Samples of milk were obtained from 8 gallon cans as they were emptied at the dairy, and analysed by standard methods[2]. In addition, in the second and third series, the bacterial contamination directly chargeable to the machines themselves was determined by "milking" four liters of sterile water[3] from a sterile artificial udder through the machines and analysing it. A summary of the data obtained appears in Table 2.

[1] Assistant Agricultural Bacteriologist.

[2] Samples from the evening's milking were held overnight at 40-50 deg. F., and analysed along with the morning's samples. The assistance of Mr. F. Trudel in the first series, and of Mr. D. G. Hewer, B.S.A., in the remaining series, is gratefully acknowledge.

[3] The sterile water "milked" from the artificial udder by the chlorine-treated units always contained sufficient sodium thiosulphate to react with the small amount of chlorine picked up, and thus prevent any germicidal action in the rinse after recovery from the milker bucket.

From the data for the first and second series it is quite evident that lye solution is a very satisfactory sterilizing agent for the well-washed milk tube system, being slightly superior to hypochlorite. Parfitt (4) reports slightly lower counts with the latter, but some of his results are open to the objection that the tests with hypochlorite were carried out in the summer of 1929, while those with lye were undertaken in 1930, and temperature differences may have favoured the hypochlorite tests.

In addition to its antiseptic action, lye solution is known to possess valuable detergent properties, dissolving casein and saponifying or emulsifying fat. It occurred to the writer that a cold lye solution acting over the period between milkings (approximately eleven hours) might be almost as effective in removing remaining traces of milk from the milk tube system as a hot washing powder solution acting for one minute or less in a suction rinse. To test this out, a series of comparative counts was run over a period of 11 weeks (December 29th, 1930—March 14th, 1931). Machines received a suction rinse with one pailful of cold water between two units, following which the milk tube systems were filled with solutions of lye (0.6%) or hypochlorite (200 parts per million available chlorine) respectively. The bacteriological data obtained are summarized under the third series in Tables 1 and 2. While the counts from the hypochlorite compare more or less favourably with those from the lye, the same could not be said of the physical cleanliness of the rubber parts. The metal reamer always removed large amounts of semi-solid residue from the hypochlorite treated tubes, while the lye treated tubes remained remarkably free from this objectionable deposit.

A similar series of tests under warm weather conditions was made between July 7th and August 26th, 1931, substituting a Chloramine-T compound for the hypochlorite, since the latter is known to be less stable at higher temperatures. Data are summarized under the fourth series in Table 1. Here again the difference in physical cleanliness of the lye and Chloramine-T treated tubes was far more marked than the difference in bacterial content of the milk drawn through them. Similar results were obtained where the tubes were immersed in the solutions in crocks instead of being placed on solution racks and filled. It would seem that the lye solution is at least the equal of either the organic or inorganic chlorine compounds in antiseptic efficiency, while capable of maintaining the tubes in a state of physical cleanliness not possible with the chlorine compounds in the absence of hot water for washing the machines.

A further series of tests was made during the late summer of 1932 (August 24th to September 16th) in which lye solution (0.4%) was compared with Metso (sodium metasilicate) solution (0.5%). The latter solution is non-corrosive for aluminum, hence may be used where lye would prove objectionable. A summary of the data appears under the fifth series in Table 1 from which it may be concluded that Metso is almost as effective as the lye solution in its antiseptic properties. No differences in physical cleanliness of the tubes were observed, both alkali solutions being effective detergents. No explanation of the higher average level of counts in this series suggests itself other than the fact that the rubber parts had seen considerable service before the start of this experiment. Both the fourth and fifth series were

TABLE 1.—*Summary of bacterial counts on milk drawn by machines treated with various sterilizing solutions.*

Series	Treatment	Date started	Total No. of counts	Percentage distribution of counts per c.c.						
				<1000	1001-2500	2501-5000	5001-10,000	10,001-20,000	20,001-50,000	>50,000
I	*Hot water suction washing* Tubes filled with lye solution 0.4%	Aug. 18, 1930	70	5.7	15.7	24.3	41.4	10.0	2.9	
II	*Hot water suction washing*									
	(*a*) Tubes filled with lye solution 0.6%	Nov. 30, 1930	51	13.2	54.7	20.8	5.7	1.9		
	(*b*) Tubes filled with hypochlorite 200 ppm.	Nov. 30, 1930	53	20.8	35.8	26.4	7.6	7.5	1.9	
III	*Cold water suction rinse*									
	(*a*) Tubes filled with lye solution 0.6%	Dec. 29, 1930	141	3.6	27.5	44.9	15.2	3.6	2.9	2.2
	(*b*) Tubes filled with hypochlorite 200 ppm.	Dec. 29, 1930	139	0.0	10.1	36.0	41.7	10.1	0.7	1.4
IV	*Cold water suction rinse*									
	(*a*) Tubes filled with lye solution 0.5%	July 7, 1931	62			3.2	40.3	45.2	6.5	4.8
	(*b*) Tubes filled with Chloramine-T 200 ppm.	July 7, 1931	63			9.5	23.8	47.6	14.3	4.8
V	*Cold water suction rinse*									
	(*a*) Tubes filled with lye solution 0.4%	Aug. 24, 1932	45				31.1	31.1	33.3	4.4
	(*b*) Tubes filled with Metso solution 0.5%	Aug. 24, 1932	45				15.6	40.0	42.2	2.2

TABLE 2.—*Summary of bacterial counts on previously sterile water after being "milked" from artificial udder by machines variously treated.*

Series	Treatment	Date started	Total No. of counts	Percentage distribution of counts per c.c. rinse							
				<25	26-100	101-250	251-500	501-1,000	1,001-5,000	5,001-10,000	>10,000
II	*Hot water suction washing*										
	(*a*) Tubes filled with lye solution 0.6%	Nov. 30, 1930	7	57.1	14.3	14.3	14.3				
	(*b*) Tubes filled with hypochlorite 200 ppm.	Nov. 30, 1930	6	66.7	33.3						
III	*Cold water suction rinse*										
	(*a*) Tubes filled with lye solution 0.6%	Dec. 29, 1930	24	16.7	29.2	16.7	8.3	8.3	16.7	4.2	
	(*b*) Tubes filled with hypochlorite 200 ppm.	Dec. 29, 1930	24			8.3	0.0	8.3	54.2	25.0	4.2

carried out during the warmer months, which doubtless accounts for the general higher level of counts in these two series.

Discussion

There exists a widespread belief that milking machines cannot be maintained in a satisfactory sanitary condition without the use of large quantities of hot water in washing the machine. In 1929 Lochhead and Johns (*2*) reported that milk of reasonably low bacterial content could be produced with cold water rinsed machines which were subsequently sterilized with hypochlorite. It was however pointed out that a more rapid decline in the strength of hypochlorite solution as well as deterioration of the rubber parts resulted when no hot water was employed in the washing process. Hence this method could not be recommended.

In the more extensive series of tests reported in the present paper, physical as well as bacteriological cleanliness has been carefully studied. From a *bacteriological* standpoint, the results obtained corroborate those previously reported. When, however, the *physical* cleanliness of the interior of the tubes is considered, it becomes apparent that the chlorine compounds cannot be considered as satisfactory where the machines receive a cold water rinse only. On the other hand, an alkaline solution made up from common flake lye combines the rôles of detergent and antiseptic or germicide in a very satisfactory manner, making possible the maintenance of the rubber tubing in a sanitary condition without the use of hot water for washing. Metso (sodium metasilicate) which next to lye is the most strongly alkaline detergent available (*1*), also proved satisfactory, although somewhat less effective against organisms of the colon-aerogenes group. Tri-sodium phosphate, the next in alkalinity, would doubtless also give good results, but washing soda, a weaker alkali, according to tests in progress at this moment, does not appear to be as effective a germicide.

Prickett (*5*) in a survey of the present status of the milking machine, estimates that the hours of labour saved by machine milking will average around 50% for herds of 20 to 25 cows, or a reduction of 25% in the total cost of milk production. One reason that many farmers are not using machines is that the older methods of caring for them consumed most, if not all, of the time saved during the milking process itself. The more recent development of the suction rinse method (replacing the older method which required the disassembling of the entire milk tube system for brushing after each milking) has made it possible to reduce the time required to care for the machines to about one-fourth of that formerly necessary. The results reported here suggest that a still further saving in time, in addition to a considerable saving in fuel, may be effected by the employment of a combined detergent and antiseptic in the form of a cold solution of lye, following a suction rinse with cold water at the finish of the milking process[4]. While this method enables the milk producer to maintain the bacterial content of his milk at a reasonably low level[5], no claim is made that counts will be as low as where large amounts

[4] Detailed directions covering the use of the lye solution may be obtained from the Division of Bacteriology, Central Experimental Farm, Ottawa.

[5] Out of 398 samples of milk from lye treated machines, only 8 have shown counts in excess of 50,000 per cc. All samples were taken from the cans as emptied at the dairy, so that the counts represent bacteria contamination from various sources as well as the machine, to say nothing of the occasional case of udder trouble.

of hot water are employed in washing the machines. The milk producer receiving a premium for extremely low count milk can afford to carry out certain steps that the bulk of producers cannot, and it is for the latter group that this method is primarily intended.

Regardless of the system employed in washing the milk tube system, lye solution for filling the tubes between milkings possesses the following advantages over the chlorine compounds commonly employed.

(1) Lye is more readily obtainable.
(2) It retains its strength better, both in solid form and in solution.
(3) Lye solution does not deteriorate as rapidly when in contact with rubber or other organic matter.
(4) A solution of the correct strength is more readily obtained. (If too strong, the rubber becomes too slippery to remain on the cows' teats).
(5) Lye is cheaper. (Soak solution costs less than 1½c per gallon).
(6) It possesses valuable detergent properties.
(7) It avoids the granular deposit reported by Parfitt (*4*) where chlorine compounds are used with hard water.
(8) Lye solution has a beneficial effect upon the rubber parts[6].
(9) Lye solution is much more effective than either hypochlorite or Chloramine-T compounds in the destruction of gas-producing organisms (colon-aerogenes group) (*3*).

As against the above, the following disadvantages have been observed:

(1) Lye solution corrodes aluminum, hence cannot be used on machines having aluminum parts *in the milk tube system.*
(2) Where only small quantities of cold water are employed in the suction rinse, and the removal of the milk residue is not as complete as it should be, the calcium phosphate present in the remaining milk residue will be precipitated by the alkaline solution, and a granular deposit will slowly accumulate on the inner walls of the inflations similar to that reported by Parfitt where chlorine compounds are employed with hard water, but to a much smaller degree.

The first objection may be met by substituting Metso (sodium metasilicate), which has proven to be practically as effective as the lye solution, while not corroding aluminum. The second, the development of a granular deposit, is best avoided by employing larger quantities of water for rinsing the tubes after milking, and particularly by rinsing *immediately*, before the milk has an opportunity to dry onto the rubber. One very effective method[7] is to attach the long milk tube to the pump and back-wash the milk tube system by pumping water through it for several minutes. Where after a period of several months such a deposit does develop it may readily be removed by soaking in a weak acid solution and brushing.

[6] In a recent article, Reid, an Australian rubber chemist (*6*) advocates soaking swollen inflations overnight in 15% lye solution followed by boiling in water for one hour. This treatment is said to remove the fat and shrink the inflation to the original size.

[7] This method is employed by Mr. L. H. Newman on his farm at Merrickville, Ontario, with very satisfactory results.

Several hundred samples of milk drawn by machines treated with lye solution have been examined with regard to the possible effect of traces of lye solution upon the flavour of the milk, but in no case has any off-flavour been detected which could reasonably be attributed to the use of the lye. Doubtless a rinse with cold water immediately before milking would reduce the bacterial contamination from the machine to some further degree, in addition to removing traces of lye solution, but the aim in these studies has been to concentrate on the absolute minimum of attention necessary to maintain the machines in an acceptable condition.

Summary

A weak lye solution as advocated by Parfitt, has proven to be the most generally satisfactory antiseptic for milking machine tubes. In addition, its detergent properties make it possible to maintain the tubes in good sanitary condition without employing hot water for washing, thus affording a means whereby milk producers lacking steam or hot water may produce an acceptable grade of milk with machine milking.

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CONSIDERATIONS HISTORIQUES SUR LES LAITS DE FERMENTATION ACIDE ET SUR LEUR FLORE MICROBIENNE*

T. G. Corminboeuf

Dans cette étude préliminaire, nous nous proposons de développer successivement les points suivants:

I.—Les produits lactés de fermentation acide dans l'histoire de l'humanité.

II.—Historique des recherches bactériologiques et chimiques sur la flore microbienne du Yoghourt et du lait acidophile.

III.—Historique des recherches relatives aux propriétés thérapeutiques de la flore microbienne du Yoghourt et du lait acidophile.

I.—Les Produits Lactes de Fermentation Acide dans L'Histoire de L'Humanite.

En étudiant l'histoire de l'alimentation et de la médecine à travers les âges de l'humanité, l'on constate que les peuples anciens utilisaient déjà de nombreuses variétés de laits spéciaux modifiés par des fermentations acide ou alcoolique. Mais seuls les laits acides, assez semblables au yoghourt et au lait acidophile, retiendront notre attention dans cette étude.

Ces laits étaient désignés, et ils le sont encore de nos jours, par des appellations diverses selon leur pays ou même leur localité d'origine. Quelques-unes de ces appellations sont tout à fait symboliques. Ainsi, le nom égyptien du lait fermenté "laben raib" signifie "boisson de la vie". Le terme assyrien "lebeny" possède la même signification. Le nom bulgare "yoghourt" veut dire "lait acide de digestion facile". Ce dernier produit était, selon la tradition ancienne, utilisé couramment comme préventif de nombreuses maladies et parfois même dans le traitement curatif de certaines d'entre elles. Il était préparé avec du lait de brebis, de bufflesse, de chèvre, de jument, de vache, de lama etc. . . . .

Pour se faire une idée de la place qu'occupait le yoghourt dans la médecine ancienne, il suffit de reproduire quelques paragraphes d'un des plus célèbres ouvrages de la médecine arabe "La Grande Explication du Pouvoir des Eléments et de la Médecine" d'Abu Mahomet Abdullah ben Ahmed, autrement nommé Ibn Baithar de Malaga, médecin de Taladin, premier sultan de Kairal. Ce fameux traité, qui parut en l'an 633 de l'Hégire, fut publié par ordre du sultan Malek Alsahla. Des manuscrits de la traduction allemande, faite par ordre de l'empereur Guillaume 1er, se retrouvent aux librairies publiques de Hambourg (Allemagne) et de Cleveland (Ohio). Les extraits de cet ouvrage qui vont suivre résument les opinions de quelques-uns des plus célèbres médecins arabes, persans, grecs, syriens et hindous de l'antiquité.

Ainsi, Maserdschavia prescrivait l'usage du "laben" contre la dysenterie et toutes les maladies inflammatoires de l'estomac, du foie, des intestins. Son ordonnance "débarassez votre organisme des poisons en les détruisant"! est restée célèbre. Hunayn écrivait: "le laben fortifie l'estomac, guérit la diarrhée, donne l'appétit, régularise la température du sang, purifie les humeurs, rend le sang plus fluide, et donne à la peau, aux lèvres et aux

* Préliminaires d'une étude expérimentale sur "Les caractères Biochimiques des Microorganismes du Yoghourt et du Lait acidophile" poursuivie aux laboratoires de biochimie de la Faculté des Sciences de l'Université de Montreal et de l'Institut Agricole d'Oka.

muqueuses, un teint de fraîcheur et de santé." Avicepna faisant allusion au lait acide s'exprimait ainsi: "Il augmente le désir du coïtus chez les natures chaudes et rend les muqueuses humides." Rhazès, qui nommait le produit "Maître d'Elschuraz", le prescrivait comme aliment rafraîchissant, nécessaire aux personnes dont le lait ordinaire tranche dans l'estomac et produit une impression de lourdeur." . . . .

Enfin, Galen déclarait que le lait fermenté est salutaire pour les personnes qui souffrent de brûlements d'estomac et d'un excès de bile, car, disait-il, "il change la nature en la purifiant." Plusieurs autres autorités médicales de l'antiquité possédaient des opinions analogues. Ainsi, Dioscoride de Tabari, Alsacharavius etc., conseillaient l'usage du laben comme aliment dans la tuberculose, les maladies du foie, de l'estomac, du sang, et en injection dans les affections suppurulantes des oreilles, du nez, de l'utérus, etc. . . . . Selon Pline, le peuple assyrien considérait le laben à la fois comme un aliment divin et un médicament universel, capable de guérir pratiquement toutes les maladies.

Un autre historien ancien, du nom de Marco Polo, parlait du yoghourt et d'un lait de fermentation acide qui occasionnait l'ivresse (C'était probablement le kéfir, produit dans lequel la fermentation alcoolique prédomine). Lemgo, voyageur et historien d'Asie, au XVIII éme siècle, décrit un endroit spécial du palais du Shah, en Perse, appelé "Yoghourt-chnek" où il se préparait un lait fermenté, le masslo, très semblable au "tayer", lait acide des Juifs. Ce lait avait la réputation de prévenir les épidémies. Les femmes persannes utilisaient un lait acide analogue, le "mosab", pour conserver la fraîcheur de leur teint.

Quelque erronées que puissent paraître ces assertions, il n'en est pas moins vrai que la science moderne reconnaît aux laits fermentés des qualités hygiéniques qui n'avaient rien d'exagéré dans certaines opinions des anciens. C'est ce que nous verrons d'ailleurs en faisant la revue historique des travaux scientifiques sur le sujet. Pour le moment disons quelques mots relatifs à la préparation et à l'usage actuels des laits fermentés du type acide dans les différents pays. Chez les peuples habitant les montagnes du Caucase, la Bulgarie, la Turquie, l'Egypte, la Sardaigne, la Sicile, la Serbie et le Monténégro, le lait fermenté occupe encore une place importante dans le régime alimentaire quotidien. Les procédés de préparation chez les différents peuples varient quelque peu, mais ils possèdent plusieurs caractères communs. Le lait frais est bouilli habituellement à petit feu, pendant un temps plus ou moins long, suivant la consistance désirée. Après l'ébullition, le produit est refroidi à 45 ou 50°C, température qu'on apprécie en plongeant les doigts dans le liquide de temps à autre. Alors on ajoute un levain, c'est-à-dire une petite quantité de lait fermenté d'une ancienne préparation, et le tout est incubé pendant quelques heures. La température d'incubation est maintenue relativement constante au moyen de vêtements de laine, dont on entoure les récipients. Grâce à la distribution quasi-universelle des lactobacilles, des streptocoques et des levures, les différents peuples ont réussi à préparer indépendamment les uns des autres divers laits fermentés présentant entre eux beaucoup d'analogie. Le lait fermenté des Bulgares, des Grecs, des Turcs et des habitants des montagnes balkaniques est désigné suivant le pays par les noms de yoghourt, yohhurt, yaoert, yohourt, jaurt, jugurt et kissélo mléko. Dans ces divers pays, on le prépare avec du lait de bufflesse, de chèvre, ou de vache, de la façon suivante: le lait est bouilli à petit feu dans un pôt de

terre jusqu'à réduction de son volume initial, d'un quart, d'une demie et même davantage. Il est ensuite refoidi entre 45 et 50°C et additionné d'une petite quantité de levain, d'une ancienne préparation, qu'on appelle maya, podkwassa ou sakwaska. La température d'incubation est réalisée comme précédemment, et elle est maintenue sensiblement constante durant 10 à 12 heures. Quand la fermentation a été normale, le produit présente alors la consistance d'une gelée, développant une saveur doucereuse, et une odeur agréable. Si l'on a soin de remuer fréquemment le lait pendant la période de maturation, le produit reste fluide, et est utilisé comme breuvage.

Le laben raib ou laban des Egyptiens est à peu de chose près identique. Il est fabriqué avec du lait de bufflesse, de chèvre ou de vache. Une petite portion du fermenté, le "riba", est mélangé avec du lait bouilli, et le mélange est incubé à 45 ou 50°C pendant 6 heures. La préparation ainsi obtenue ressemble au yoghourt mais elle possède une texture plus grossière. Gorini donne une description d'un lait fermenté similaire, le "skorup", utilisé en Serbie et au Monténégro. Ce produit, au lieu d'être fabriqué avec du lait entier, est préparé avec de la crème ou du lait partiellement évaporé. Le skorup possède après maturation une consistance crémeuse et développe une saveur acide agréable. Il est fréquemment consommé après avoir été additionné de pommes de terre ou d'autres aliments solides.

En Arménie, on utilise un breuvage lacté intermédiaire entre le yoghourt et le lait fermenté ordinaire, dans lequel la fermentation alcoolique domine la fermentation acide. Ce produit est fabriqué avec du lait de bufflesse, de brebis, de chèvre ou de vache, et est connu sous les noms de "mazun" ou de "matzoon". Le lait est bouilli puis refoidi à la température du sang (37.5°C). Un levain de mazun est mélangé avec du lait et de l'eau; ce mélange est ajouté au lait bouilli qu'on désire transformer. Après une incubation de 12 à 18 heures, le produit peut être consommé. Le mazun est un caillé solide possédant une saveur et une odeur caractéristiques. Il est consommé comme tel ou comme breuvage après avoir été étendu d'eau.

En Norvège et en Suède, on prépare un lait fermenté qu'on appelle "taite melk", kjernemelk, ou tattenjolk. C'est un produit épais, visqueux, dont la saveur et l'odeur rappelent le fromage. Le départ de la fermentation est assuré par l'adjonction au lait de feuilles de Pinguicula vulgaris ou d'une variété de Drosera, plantes très répandues dans ces pays. La température la plus favorable à cette fermentation est de 37.5°C.

Il se prépare en Bretagne un lait fermenté à propriétés analogues, connu sous le nom de Gros Lait.

En France, en Allemagne, en Autriche, en Suisse et au Canada, grâce aux acquisitions scientifiques récentes sur le sujet, le yoghourt se fabrique selon des précédés industriels, variables, mais toujours sur la base d'un contrôle bactériologique et chimique constant des matières premières (laits et cultures bactériennes.)

L'introduction du yoghourt au Canada (yoghourt et lait bulgare ne sont pas synonymes) remonte à 1928. Elle est l'oeuvre du Dr. J. M. Rosell, distingué bactériologiste de l'Institut Agricole d'Oka, dont la renommée a passé les frontières de notre pays. C'est à lui que reviennent l'honneur et le mérite d'avoir introduit dans le pays les premières cultures pures indispensables à la préparation du véritable yoghourt et d'avoir divulgué largement les connaissances bactériologiques et médicales relatives à la préparation et aux

usages de ce produit. Pour s'en rendre compte, il suffira de consulter l'une ou l'autre de ses nombreuses publications (voyez à ce sujet les index bibliographiques de parties I, II, et III.)

Aux Etats-Unis, il existe principalement deux types de lait acide, qui sont: le babeurre acide (acid-buttermilk), et le lait acidophile (Lactobacillus acidophilus milk ou Acidophilus milk).

Le babeurre acide est le produit d'une fermentation lactique du lait écrémé (skimmilk) et plus fréquemment du petit-lait qui se sépare de la matière grasse dans l'opération du barattage de la crème. Sa préparation est très simple . Le lait écrémé ou le babeurre provenant d'une crème douce est pasteurisé, puis refroidi à 21-24°C, pour être inoculé avec un levain lactique (starter). A cette température l'acidification est lente et par suite la coagulation également. Il en résulte un coagulum très fin et friable qui précipite lentement, mais qu'il est facile de maintenir en suspension en agitant de temps à autre. Aussitôt que ce résultat est obtenu, on refroidit la préparation à 50°F (10°C.) afin d'empêcher la rétraction du caillé et la séparation du lactosérum. Lorsqu'on utilise pour la fabrication du beurre une crème acide (c'est la pratique habituelle), d'acidification spontanée ou provoquée, le sous-produit constitue naturellement du lait de beurre acide. Quand la fermentation est spontanée, le babeurre peut renfermer des bactéries indésirables, formant à côté de l'acide lactique, qui résulte d'une fermentation normale, des acides volatils (acétique, formique, butyrique etc.) en quantités plus ou moins considérables, donnant un produit de mauvaise qualité. Le babeurre d'une telle provenance est fréquemment amélioré à l'aide d'une culture de B. bulgaricus en lait écrémé qu'on ajoute dans la proportion de 10%. Celle-ci communique à la préparation une odeur et une saveur plus agréables, ainsi qu'une meilleure texture qui prévient la séparation du lactosérum (wheying off).

Quant au lait acidophile, il s'est répandu très rapidement aux Etats-Unis, depuis une décade, c'est-à-dire à la suite des premières recherches de Rettger, Cheplin, Kopeloff, Bass, etc. . . . établissant la valeur médicale de ce produit. Sa préparation est beaucoup plus délicate que celle du babeurre acide, surtout lorsqu'on en attend des effets thérapeutiques. Cela tient particulièrement, ainsi que nous le verrons plus loin, à la lenteur d'action du L. acidophilus, et à la grande facilité de contamination des cultures lactées lorsque l'acidité n'est pas suffisante pour inhiber le développement des microorganismes indésirables. La fabrication du lait acidophile aux Etats-Unis est réalisée, comme la préparation du Yoghourt au Canada, sur une base commerciale, à l'aide d'installations spéciales, et, en rapport avec elles, de laboratoires destinés à l'isolement et à la propagation des cultures ainsi qu'au contrôle chimique et bactériologique du lait. Celui-ci doit être au point de vue bactériologique aussi propre que possible. On se sert de lait de vache entier ou écrémé partiellement ou totalement. Le lait devant être transformé est d'abord pasteurisé par la méthode dite "intermittente" (tyndalisation) ou stérilisé sous pression.

La première méthode consiste à chauffer le lait à 91-93 degrés C durant 30 minutes, à le refroidir à 31-33 degrés C pour une incubation à cette température de 3 à 5 heures, à le chauffer de nouveau à 91-93 degrés C pendant 30 minutes. Dans le deuxième procédé, le lait est chauffé à 118-121 degrés C durant 30 minutes et sous une pression de 12 à 15 livres, puis il est refroidi à

la température d'incubation de 37 degrés C. Ce procédé présente sur le précédent le double avantage d'être plus rapide et d'une efficacité plus certaine. Il possède par contre l'inconvénient de caraméliser le lait. Le produit stérilisé par l'une ou l'autre de ces méthodes est refroidi à 37-38 degrés C pour être inoculé avec 2% d'une culture mère de L. Acidophilus et maintenu à cette température jusqu'à ce que le caillé soit recouvert d'une petite quantité de lactosérum. Ce résultat est généralement obtenu au bout de 12 à 18 heures. Alors le lait acidophilé est homogénéisé, puis embouteillé (*4*). Pour prévenir la rétraction du coagulum durant la période d'entreposage, on recommande un refroidissement à 15.5 degrés C avant l'agitation. Knaysi (*3*) propose une méthode de préparation plus économique et plus rapide. Elle consiste, brièvement, à incuber le lait à 37-40 degrés C, durant 2½ à 3 heures, puis à le chauffer aussi près que possible de son point d'ébullition durant 30 minutes, enfin à le refroidir rapidement à 37-40 degrés C pour l'inoculation et l'incubation.

Les cultures mères sont faites en lait stérile, généralement de la façon suivante (*4*): le lait est stérilisé durant 30 minutes à 118 degrés C, sous une pression de 20 livres, refroidi à 37.5 degrés C, inoculé avec 2 à 5% d'une culture de L. Acidophilus récemment isolée, (de l'intestin ou des matières fécales d'un sujet au régime lactosé) et incubé à cette température pendant 12 à 18 heures.

Des lignes qui précèdent, nous devons retenir notamment les idées suivantes:

1. Les produits lactés de fermentation acide possèdent depuis les temps les plus reculés une réputation quasi-universelle.
2. La fabrication domestique de ces produits a eu sa raison d'être dans les âges où l'on ignorait tout de la nature et de la spécificité des fermentations.
3. Les acquisitions scientifiques modernes (dont les détails paraîtront dans les numéros subséquents) ont rendu possible la préparation industrielle de laits fermentés spéciaux possèdant une composition et des propriétés bien définies. Dès lors, la question des laits fermentés devient, pour un pays qui s'en occupe, un problème d'une grande importance au double point de vue de l'hygiène publique et de l'économie laitière.

NOTA.—Pour la rédaction de cette première partie nous nous sommes inspirés des monographies et publications suivantes, que nous recommandons à ceux qui désirent une documentation historique portant également sur les laits modifiés "de fermentation alcoolique" tels le Képhir, le Kumiss, l'Omeira, le Taryk, etc. . . . .

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RESUME DES ARTICLES PUBLIES EN ANGLAIS DANS CE NUMERO

VARIATIONS DANS LE CLIMAT ET LE LAVAGE DU SOL PAR LES EAUX DU DRAINAGE DANS LA PROVINCE DE QUEBEC. R. R. McKibbin, Collège Macdonald, P.Q.

L'histoire climatique récente de la Province de Québec est celle d'une période glacière. La dernière glaciation a profondément affecté les sols tels qu'ils existent aujourd'hui. Ces sols n'ont pas encore atteint un niveau d'équilibre avec leur milieu. Bien que l'altitude et la pente causent des variations importantes dans le climat du Québec méridional, la longitude semble être le facteur le plus important. En général quand on va d'ouest en est la quantité de précipitation atmosphérique augmente tandis que la température, la longueur de la période végétative et l'incidence de la lumière solaire diminuent.

Un facteur indiquant le degré de lavage des terres a été développé et appliqué aux données météorologiques recueillies dans 21 stations de la Province de Québec. Ce facteur est obtenu pour une région donnée en faisant le rapport entre l'excès de précipitation au-dessus d'une base donnée exprimé en pouces et l'excès de température au-dessus d'une base donnée exprimé en degrés Fahrenheit.

EXPERIENCES SUR LE CONTROLE DES ROUILLES DE L'AVOINE PAR LE SOUFRE PULVERISE. F. J. Greaney, Laboratoire Fédéral de Recherches sur la Rouille, Winnipeg, Man.

La rouille de la tige et la rouille de la couronne ont été effectivement contrôlées par l'application de soufre pulvérisé même dans les cas d'attaques sévères. La méthode de contrôle ne s'applique pas aux grandes surfaces mais elle présente de l'intérêt pour le travail avec des parcelles. D'autre part c'est un pas intéressant de fait vers le contrôle de la rouille dans les conditions de la grande culture.

L'auteur a trouvé que chaque 10% de rouille de la tige a réduit la récolte de l'avoine de 7%.

LA FARINE DE POISSON COMME ALIMENT DE COMPLEMENT POUR LES POUSSINS. II. V. S. Asmundson et J. Biely, Université de la Colombie Britannique, Vancouver, B.C.

Dans la première partie de cet article qu'a récemment publiée "La Revue Agronomique", il était rapporté que la croissance de poussins recevant un supplément de ration sous forme de farine de saumon ou de sardine était aussi rapide que celle de poussins recevant un supplément de ration sous forme de lait écrémé séché. La seconde partie de l'article montre qu'une combinaison de farine de poisson et de lait écrémé séché a produit une croissance plus rapide que la farine de poisson seule.

ETUDE SUR L'AMPUTATION DES RACINES DU BLE EN RELATION AVEC LES MALADIES DU SYSTEME RADICULAIRE. P. M. Simmonds et B. J. Sallans, Laboratoire Fédéral de Pathologie végétale, Saskatoon, Sask.

Les auteurs ont essayé, en blessant artificiellement des racines de blé, de reproduire des réactions caractéristiques de la pourriture des racines. Le fait qu'une blessure artificielle à certaines parties du système radiculaire produit des symptômes semblables à ceux de la pourriture des racines jette une lumière intéressante sur l'action d'une attaque de pourriture à diverses périodes de la vie de la plante.

LES SOLS DU SUD DE L'ONTARIO. F. W. Morwick, Collège Agricole de l'Ontario, Guelph, Ont.

Les sols étudiés se trouvent en plusieurs comtés du sud-ouest de l'Ontario et dans un comté de l'est de la province. Les principales divisions des sols étudiés y sont brièvement décrites.

Cette étude fait partie d'une enquête entreprise par le Groupe des Sols de la C.S.T.A. en vue d'établir une carte pédologique du Canada.

Transmission par la Graine des Maladies du Bariolage et de la Mosaique des Tomates. *II.* G. H. Berkeley et G. O. Madden, Laboratoire de Pathologie Végétale. St. Catharines, Ont.

Au cours d'un article publié il y a quelque temps dans "La Revue Agronomique" les auteurs ont montrés que les maladies du bariolage et de la mosaïque des tomates peuvent être transmises par la graine, bien que dans certains cas des graines provenant de plantes affectées et placées dans les mêmes conditions de milieu que les autres produisent des plantes sans aucun symptôme de mosaïque ou de bariolage.

Au cours du présent article les auteurs contrent que les graines provenant de certaines inflorescences d'ne plante atteinte de mosaïque peuvent produire la maladie alors que des graines provenant d'autres inflorescences de la même ne reproduisent pas la maladie. Les auteurs montrent aussi que le principe infectant peut être présent dans des graines provenant de fruits verts aussi bien que de fruits mûrs. Naturellement il est recommandé aux horticulteurs d'éliminer entièrement les plantes affectées et de récolter leurs graines uniquement de plantes saines.

Croisements Naturels entre l'Avoine Cultive et la Folle Avoine. R. A. Derick, Ferme Expérimentale Centrale, Ottawa, Ont.

L'auteur a trouvé que lorsqu'au centre d'un bloc d'avoine cultivée on semait de la folle avoine *Avena fatua* il se produisait un croisement naturel allant jusqu'à 1/3 de 1%. Il est important pour les sélectionneurs et pour les producteurs de semence pure d'être avertis de ce fait.

Methode simplifiee de Nettoyage du Caoutchouc des Machines a traire. C. K. Johns, Ferme Expérimentale Centrale, Ottawa, Ont.

Une solution de lessive faible (0.4-0.6%) s'est montrée l'agent chimique le plus satisfaisant pour prévenir la croissance des bactéries dans les tuyaux entre les traites. Ses propriétés détersives rendent possible le maintien des tuyaux en bonne condition sanitaire sans employer d'eau chaude pour les laver. Le système de tuyaux est soigneusement rinsé à l'eau froide aussitôt après la traite de la dernière vache, puis placé sur un support et rempli d'un solution de lessive. Immédiatement avant la traite suivante la solution de lessive est drainée, les tuyaux rinsés à l'eau froide et les diverses unités remises en place pour la traite.

Cette méthode simplifie grandement l'entretien des machines et épargne du temps et du combustible, réduisant ainsi les frais de production. Elle s'est montrée satisfaisante pendant une période de plusieurs mois dans les étables de la Ferme Expérimentale Centrale à Ottawa.

Rapport du Comite charge de coordonner les Divisions des Provinces des Prairies en Zones correspondantes aux Varietes de Cereales. J. B. Harrington, Université de la Saskatchewan, Saskatoon, Sask.

Le travail préliminaire fait par le céréaliste fédéral en vue de la division des Provinces des Prairies en zones correspondant aux variétés de céréales fut suivi en 1927 d'efforts dans le même sens par les gouvernements provinciaux des Provinces des Prairies. Les trois gouvernements publièrent en 1930 les résultats des travaux entrepris. Malheureusement les lignes de démarcation des zones ne concordaient pas aux frontières des Provinces. En 1929, à la réunion de la Société d'Agronomie de l'Ouest du Canada tenue à Edmonton, un comité de coordination fut établi. L'article présent est le dernier rapport de ce comité. Il est accompagné d'une carte montrant clairement les différentes zones.

REPORT OF THE COMMITTEE ON THE CO-ORDINATION OF CEREAL VARIETY ZONES IN THE PRAIRIE PROVINCES[1]

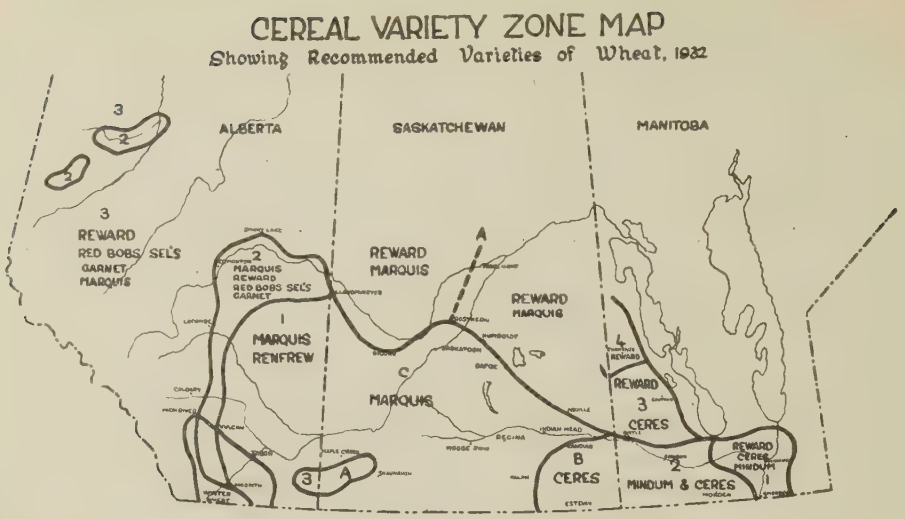
The Cereal Variety Zonation Committee of the Western Canadian Society of Agronomy was formed at the Edmonton meeting of the society in December, 1929, and consisted of the chairmen of the cereal variety committees of the three prairie provinces. At the annual meeting of the society in Winnipeg in December, 1930, the committee was enlarged. The purpose of the committee is to co-ordinate the cereal variety zone boundaries at the provincial boundaries of the three prairie provinces . The committee is composed as follows: Dr. J. B. Harrington (chairman), University of Saskatchewan, Saskatoon, Saskatchewan; Dr. O. S. Aamodt, University of Alberta, Edmonton; Mr. J. G. Davidson, Dominion Experimental Farm, Indian Head, Saskatchewan; Professor A. T. Elders, Manitoba Agricultural College, Winnipeg; Mr. W. D. Hays, Dominion Experimental Farm, Lethbridge, Alberta; Mr. S. J. Sigfusson, Dominion Experimental Farm, Brandon, Manitoba.

Varietal zonation in Western Canada was undertaken on a provincial basis in 1927. Previous to 1927, Mr. L. H. Newman, Dominion Cerealist of the Dominion Experimental Farms Branch, did pioneer work in that connection. He commenced in 1924 a series of co-operative comparative variety tests with farmers in various parts of the Prairie Provinces with the object of preparing a map defining zones within which certain varieties could be recommended safely. In 1927 the Alberta Varietal Zonation Committee was appointed, data were collected and a preliminary map was made. In the same year the Manitoba agronomists outlined a preliminary cereal variety zonation of their province and this was published through the Wheat Pool in 1928. In Saskatchewan, the zonation of the province for wheat, barley and oats was proposed by the Cereal Variety Committee in February, 1928, at the first conference of Saskatchewan agronomists, and a zone map was established. In 1929, 1930 and 1931 the zone maps of the different provinces were amended as necessary and given publicity in various ways. With the publication of cereal variety zones in the three prairie provinces it became evident during 1930 that some co-ordination of the zone boundaries should be effected so that the zone maps of adjacent provinces would be consistent. Naturally, farmers living near a provincial boundary would be confused by a zone line of one province reaching the boundary twenty or thirty miles from a comparable zone line of an adjacent province.

The committee on varietal zonation had a brief meeting before the end of the meeting of the Western Canadian Society of Agronomy in December, 1930. Tentative adjustments were made at that time, and later by means of correspondence final changes in the eastern extremities of the Alberta zone boundaries, the western extremities of the Manitoba zone boundaries, and the extremities of the Saskatchewan zone lines at both boundaries were made and approved by the respective cereal committees of the three provinces. The co-ordinated zone boundaries established early in 1931 are the same now as no changes were made during the past winter.

Following is a brief description of the zones and their boundaries as far as the work of this committee is concerned. In Manitoba the boundary between Zones 2 and 3 reaches Saskatchewan between townships 17 and 18 where it becomes the boundary between Zones A and B in Saskatchewan. South of this line, the

[1]Presented by the chairman at the Annual Meeting of the Western Canadian Society of Agronomy at Winnipeg, June 14, 1932, in conjunction with the Annual Convention of the Canadian Society of Technical Agriculturists.



wheats recommended are Mindum and Ceres in Manitoba and Ceres in Saskatchewan. North of this line Reward and, to a limited extent, Marquis are recommended in Saskatchewan whereas Ceres, and further north, Reward are recommended in Manitoba. Considering the greater rust hazard in Manitoba, the recommendations are quite consistent. The boundary between Saskatchewan Zones A and C reaches Alberta between townships 47 and 48 where it forks, becoming to the north the boundary between Alberta Zones 2 and 3 and to the west, the boundary between Zones 1 and 2. In Saskatchewan, Marquis is recommended for Zone C, and Reward or Marquis to the north in Zone A. In Alberta, the longest season zone (Zone 1) has Marquis and Renfrew recommended, Zone 2 has Marquis, Reward, Red Bobs Selections and Garnet in the order named and the short season zone (Zone 3) has Reward, Red Bobs Selections, Garnet and Marquis recommended in the order named. The Cypress Hills region, a high elevation area lying in the extreme southeastern part of Alberta and southwestern part of Saskatchewan is classed as part of the short season zone in each province. The southern boundary of this area crosses the Alberta-Saskatchewan line between townships 4 and 5 and the northern boundary crosses in the middle of township 9.

There is still one point where some question might arise as to the zone co-ordination. The boundary between Manitoba Zones 3 and 4 reaches the Saskatchewan boundary at about township 34 but there is no corresponding zone line in Saskatchewan. It is possible that a further northern zone may be established in Saskatchewan which would be bounded on the south by a line meeting the Manitoba boundary between Zones 3 and 4 and connecting at the Alberta boundary with the line between Zones 2 and 3 at about township 52 where the line originally reached the Saskatchewan boundary.

Figure 1 shows the co-ordinated zones of the three prairie provinces with the recommended varieties of wheat. The Committee wishes to point out that while definite zones make necessary the exact location of boundary lines and while the co-ordination of these lines with those of the zones of the adjacent provinces requires that they be described accurately, it should be remembered that a line separating two zones is arbitrary. The Committee also wishes to point out that only those varieties are recommended which have proven satisfactory for general usage over relatively large areas. In this connection the Committee recognizes the

fact that soil types vary greatly within the different zones and that the best variety in a certain local district is sometimes one that is not recommended in general for the zone concerned. Information on these exceptional cases is usually obtainable from the nearest experiment station.

The work of the Varietal Zonation Committee has been comparatively light due to the excellent co-operation of the cereal committee on the three provinces. There is every reason to believe that subsequent changes that may be made in the zone boundaries or the recommendations of any of the provinces will be made with full regard to the boundary lines and recommendations of the adjacent provinces. This is to be accomplished by the provincial cereal committees informing the Varietal Zonation Committee of any proposed changes at the provincial boundaries so that that committee may arrange whatever adjustments are necessary for the maintenance of zone co-ordination.

J. B. HARRINGTON,
Professor of Field Husbandry,
University of Saskatchewan.

June 14, 1932.

CURRENT PUBLICATIONS

GROWTH AND THE DEVELOPMENT OF MUTTON QUALITIES IN THE SHEEP. A survey of the Problems involved in Meat Production. John Hammond, with a section in conjunction with A. B. Appleton. Pp. xxv + 597; 10 appendices, 139 tables, 71 diagrams, 137 photographic figures. Oliver and Boyd, Edinburgh. £2, 2s.

During recent years much work has been done in connection with growth and nutritional studies in farm animals. It has remained for Mr. Hammond, however, to develop the studies of growth in mutton sheep along new lines, *e.g.*, by keeping the general conformation of the animals constantly before him and adopting weight as the basis of his investigation. This decision to use weight and composition of muscle and bone (meat) coupled with general observations as to conformation and balance rather than body measurements, the method so often used by previous investigators, is in no small measure responsible for the excellent results obtained.

The general trend of the investigation is well stated by Mr. Hammond in the introduction:—

> "The main lines which the investigation took were, firstly, the study of the factors which influence the rate of growth in live weight of the individuals of a flock, and secondly, the determination of the composition of the growth made at different periods in terms of body organs and tissues and the factors which influence this. The first is more directly the farmer's point of view and the second that of the butcher, a combination of the two being the aim of the live stock improver.
>
> "One of the problems that confronts the breeder who is selecting on scientific lines is to know how far the characters he is selecting for are genetic, and how far they are dependent on environmental conditions. By determining the direction and extent of environmental variability in weight and composition, one will be in a better position to judge the true genetic value of any animal."

The book is divided into five parts, each dealing exhaustively with a definite phase of the subject. Part I treats mainly the growth in live weight in a flock of

Suffolk sheep. In the discussion of the effect of sex on growth, the statement regarding the "generative ferment" as a substance required by both the somatic tissues and gonads leaves room for argument. In fact, the most recent work indicates that only the somatic tissues need be considered. The diagnosis showing growth of curves of rams, wethers and ewes, also singles, twins and triplets, bears out the observations of practical shepherds. To quote:

> "It will be noted in Diagram II that the curve for the rams has a marked depression at the 7th-12th weeks, and that a less marked one is also apparent in that of the wethers at the same time. A possible explanation of this is that temporary unfavorable conditions affect rams more than wethers and to a much greater extent than ewes."

This is exactly what happens in flocks of sheep under range conditions. Ewe lambs will winter much better than either wether or ram lambs. More losses will occur among the two latter, particularly if weather conditions are variable or food supplies inadequate. We are inclined to think that this difference is not due to castration but is mainly inherent. The conclusion that the main difference in development between singles and twins is nutritional will meet with general approval and only tends to emphasize the fact that capacity to produce milk in abundance is of prime importance when selecting breeding ewes. The findings in connection with the influence of the sire and the dam on birth weights are not entirely convincing. This point can only be cleared up by making large numbers of reciprocal crosses. Even then the nutritional factors present in the ewe stocks will probably require careful consideration. In part II, the carcase percentage and the relative development of the different organs in the body is discussed under two headings: (1) Causes of variation in carcase percentage, (2) The relative development of different organs. The carcase percentage in sheep increases with age. It was found that Southdowns and Suffolks at five months gave dressing percentages of 63.1 and 62.2 respectively, while later maturing breeds such as the Lincoln gave 57.2% at the same age. Early maturity is therefore stressed.

The section referring to the relative development of different organs is of special interest. Mr. Hammond demonstrates very clearly in diagramatic fashion that each organ has a growth rate of its own or that different organs develop at different times. Some very interesting passages dealing with the effect of domestication on the skeleton and general type of meat animals is given In discussing development and improvement of types, he says:

> "As a general conclusion, it is considered that the main method of evolution is directive and not dependent on the large mutations which occur. Developmental changes in the animal directed by the environment form the main basis of evolution, and, although mutations give rise to new characters, it is not in these characters that the main difference between species lies, but rather they consist of developmental changes. Thus, in our opinion, selection in a suitable environment is the method by which the evolution of domestic animals for productive purposes has proceeded; that is, by the continuous variability in the animal proceeding on definite lines induced by the environment, and not by the accumulation of separate mutations, which may, and do, arise independently in the germ plasm."

Part III, dealing as it does with the variations in the rate of development of different parts of the skeleton, is intensely interesting. The various anatomical parts of the sheep are considered in turn. There is evidence to show that the relation between length of bone and thickness of bone has changed with breed improvement.

Although the conclusions concerning bone development and proportion are based on small numbers of animals, nevertheless the author has definitely pointed the need for further investigational work along similar lines. His conclusion leads him to say:

> "In improvement of the animal form and proportions, breeding and feeding go hand in hand; by feeding we supply more available energy for the animal, and by breeding we conserve this supply for the purpose for which it is required by limiting the output in other ways. Hence when we underfeed well-bred animals, we obtain body conformations approaching those of badly bred animals."

In part IV, variations in the proportion of muscle, fat and bone in the carcase are discussed. Considerable difference of opinion exists as to the age at which the most economic gains are made in domestic animals. Mr. Hammond shows that the maximum growth of muscle, fat and bone takes place at different periods in the life of the fattening animals, thus complicating somewhat the making of definite conclusions relative to the most advantageous age at which to slaughter. The great difference between the early and late maturing breeds in point of development of muscle, fat and bone is discussed at some length. His findings here tend to point to the development of earlier maturing animals. This coincides with modern demand for relatively small joints.

Part V deals with a study of a leg of mutton. This chapter is written in conjunction with A. P. Appleton, M.A., M.D., and deals largely with the histology of the muscles. The histological basis is adhered to throughout and the development of the muscles and the effect of age, sex, breed, habitat and finish on them is taken up in great detail.

Until this monograph appeared a few months ago, students of agricultural science had no comprehensive text on the subject of growth and development in meat producing animals. Mr. Hammond has supplied this need. There is evidence that the investigational work has been well planned and carefully carried out. The conclusions arrived at, which invariably take into consideration the economic and practical aspect of the question as well as the purely scientific side, indicate the very wide grasp of the subject possessed by the author. It is a book we would heartily recommend to all advanced students of Aninmal Husbandry. It should have a place in all agricultural libraries. —A. M. Shaw.

CONCERNING THE C.S.T.A.

WESTERN BRANCHES OF THE C.S.T.A. IN GOOD CONDITION

In spite of the difficulties which beset them, the western branches of the C.S.T.A. are carrying on their usual activities. The General Secretary, H. L. Trueman, has just returned from a month's trip through the prairie provinces and British Columbia where contacts were made with all local branches of the Society. One of the main reasons for the trip west was to attend a meeting of the Programme Committee of the World's Grain Exhibition and Conference. Several days were spent in Regina making detailed arrangements for the joint sessions of the C.S.T.A. Convention and the Grain Conference. Further information regarding these arrangements is given in the news item on this subject.

The General Secretary proceeded west from Regina and visited the South Alberta members at both Calgary and Lethbridge. Meetings were held in British Columbia at Kelowna in the Okanagan Valley, at the University of British Columbia at Vancouver and in the Parliament Buildings at Victoria. Returning across the northern route, meetings were held at the University of Alberta at Edmonton and the University of Saskatchewan at Saskatoon. A second visit was paid to Regina where further work was done on the Conference programme. On the way home meetings were held at Winnipeg and Fort William. Between meetings and visits to offices the General Secretary was able to see a large proportion of the western members. Meetings were well attended, and the report of the past year's work and the prospects for a good convention at Regina lent enthusiasm to the gatherings.

The interchange of ideas between the General Secretary and the members on such occasions is invaluable from the standpoint of the progress of the Society. Provision had not been made for such a trip this year owing to the difficulty of securing sufficient funds, but assistance was forthcoming to attend the programme committee meeting of the World's Grain Exhibition and the officers of the C.S.T.A. felt that the trip should be continued on from Regina. This was done at a minimum of cost to the Society. Sufficient advertising was sold during the trip to practically pay the cost. The value of the trip to the Society as a whole at this critical time can hardly be estimated. Members from the east who visit Regina next summer will find the western branches of the C.S.T.A. carrying on their full share of the activities of the Society with the same progressive spirit they have always shown.

ELECTION OF C.S.T.A. OFFICERS IN APRIL

Nominations for Dominion officers of the C.S.T.A. close on March 15th and ballots will be prepared and mailed to members shortly after that date. The President for the year 1933-34 will be chosen from among the French members of the Society and will take office at the close of the 1933 Convention in Regina. Dr. G. I. Christie, President for 1932-33, will preside at the Regina Convention and the new President will preside at the 1934 Convention. Other officers to be elected are an English-speaking Vice-President, a French-speaking Vice-President and an Honorary Secretary. Ballots will be counted late in April and the results of the election announced in the May issue of *Scientific Agriculture*. All members are urged to vote. Approximately two-thirds of the members vote each year. While this is a high percentage for a mail ballot there is no good reason why it should not be even higher. Ballots will be printed in both French and English.

NOTES AND NEWS

W. J. White (Saskatchewan '32) has changed his address to Dominion Forage Crop Laboratory, University of Saskatchewan, Saskatoon.

G. A. Ledingham (Saskatchewan '27) who has been doing post-graduate work at Harvard University is now located at the National Research Council Laboratories, Ottawa.

Maude A. Allen (British Columbia '26) is taking work in education at the University of British Columbia, Vancouver, and is located at 956 West 14th Avenue.

H. S. Fry (Toronto '14) has purchased an interest in the Regina Book Store. This is in a good location in the centre of the city and members of the C.S.T.A. passing through Regina are invited to pay him a visit.

D. C. McArthur (Toronto 21) formerly with the Chilean Nitrate Educational Bureau, Inc., has become News Editor of the Weekly Sun at Toronto. Mr. McArthur was formerly editor on the staff of this paper when it was known as the Farmer's Sun. It is the intention of this publication, under the leadership of Graham Spry, to develop a weekly newspaper with an aggressive editorial policy.

NEW MEMBERS

The following applications for regular membership have been received since December 1st, 1932:

F. A. Blanchard (Oka 1931, B.S.A.), Caraquet, N.B.

I. Eisenberg (Vienna 1920, Ing. Agron.), Regina, Sask.

F. L. Ferguson (Toronto 1918, B.S.A.), Toronto, Ont.

H. E. Gray (Alberta 1923, B.A.), Winnipeg, Man.

F. B. Johnston (British Columbia 1928, M.A.), Ottawa, Ont.

A. J. MacDonald (McGill 1932, B.S.A.), Glenora, N.S.

C. V. Parker (Manitoba 1930, B.S.A.), Winnipeg, Man.

L. C. Paul (Saskatchewan 1932, B.Sc.), Saskatoon, Sask.

Andrew Stewart (Manitoba 1931, B.S.A.), Winnipeg, Man.

J. G. Stothart (McGill 1932, B.S.A.), Ottawa, Ont.

Wm. Tildesley (Manitoba 1931, B.S.A.), Winnipeg, Man.

W. J. White (Saskatchewan 1932, B.S.A.), Saskatoon, Sask.

C. S. T. A. COMMITTEE ON RESEARCH

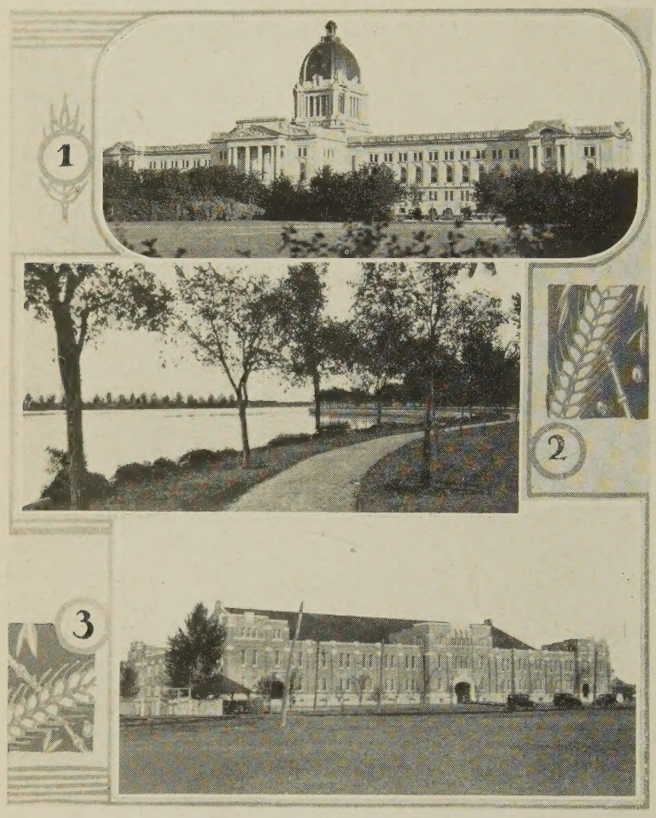
Locals which have, during the past season, prepared reports on research or which have carried out other organized research activities are requested to forward data not later than April 1st to W. H. Brittain, Chairman, C.S.T.A. Committee on Research, Macdonald College, P.Q.

ANNUAL ONTARIO BOWLING COMPETITION

During the weeks commencing January 23rd and February 20th, 1933, scores for bowling were forwarded to the General Secretary by the Central Ontario local at Toronto, the Niagara local at Hamilton, and the Eastern Ontario local at Ottawa. For the first week the average score per player per string was: Toronto 171.8; Ottawa 165.7; Niagara 157.2. The second week the scores stood: Toronto 183.5; Niagara 155.4; Ottawa 128.4. The laurel wreath goes to Toronto. Nerves at Ottawa were apparently shaky during the week of February 20th.

WORLD'S GRAIN SHOW AND C.S.T.A. CONVENTION AT REGINA.

Further details concerning the joint session of the C.S.T.A. and the World's Grain Conference were arranged by the General Secretary of the C.S.T.A. during a recent trip to Regina. The executive of the South Saskatchewan local will have charge of the local arrangements. Accommodation for C. S. T. A. members and their wives is being reserved in Regina College at the usual convention rates. Entertainment is largely in the hands of the Grain Show entertainment committee.



POINTS OF INTEREST IN REGINA, THE CAPITAL CITY OF SASKATCHEWAN
1. Parliament Building. 2. City Park. 3. Armouries where general sessions of the World's Grain Exhibition and Conference will be held.

Morning sessions of the Grain Conference will be held in the armories on the grounds of the Regina Exhibition. These sessions will be directed by the programme committee of the Grain Conference and will be under the chairmanship of outstanding leaders in Canadian political and economic life. The general subject will be the economics of the wheat situation.

Afternoon sessions will be of a technical nature and will be under the chairmanship of the officers of the various affiliated societies and groups of the C.S.T.A. At the present time these groups are building up programmes in agronomy, soils, cereal chemistry, phytopathology, entomology, economics, engineering, animal production and horticulture. These programmes will be dovetailed as much as possible and several joint sessions of various groups will be arranged. Many outstanding scientists from the United States and other countries will be present to address the technical sessions.

Final details of arrangement concerning the various sessions will be largely in the hands of a small committee at Ottawa working with Dr. Archibald as chairman of the programme committee of the Grain Show. H. L. Trueman is acting as secretary of this committee and the Board of Editors of *Scientific Agriculture* will determine the value of the papers presented and will edit the Proceedings. Arrangements for printing the Proceedings will be largely in the hands of the Managing Editor of *Scientific Agriculture*.